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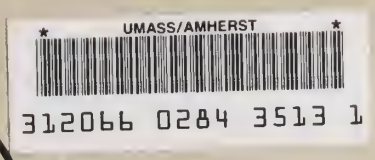


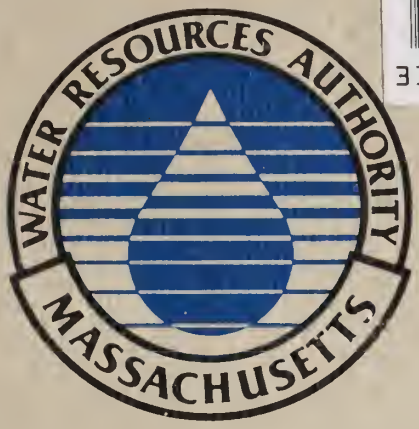


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Secondary Treatment Facilities Plan

**Volume III**

**Treatment Plant**

# DRAFT REPORT

November 3, 1987

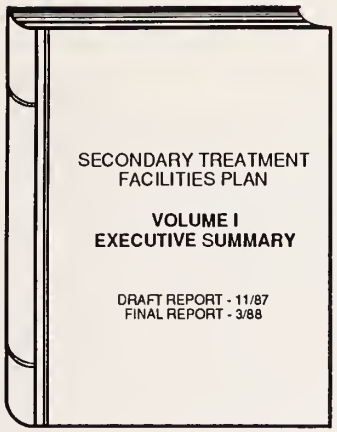
**Notice to Reviewers**

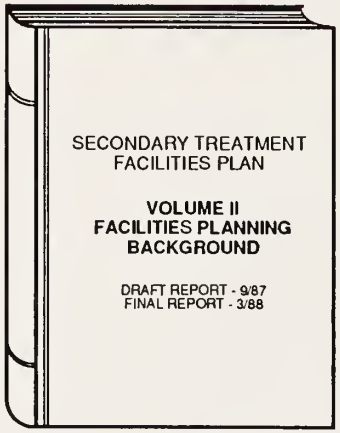
Attached for your review is the draft report of Volume III, Treatment Plant, of the Secondary Treatment Facilities Plan.

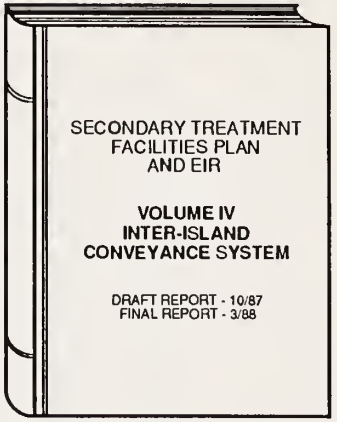
To date, Volume III has received MWRA staff review. The MWRA Board of Directors has been briefed on its contents, but no approval will be issued until the public review process is complete. The report is being circulated at this time to seek early review and comment by interested parties. Comments will be presented to the Board of Directors as they continue their review of the draft report.

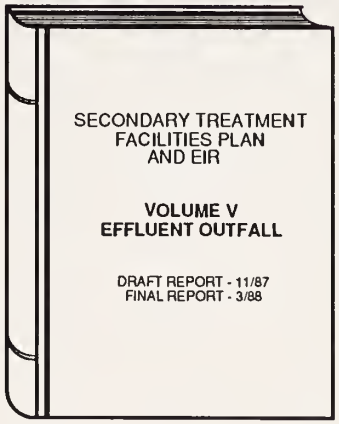
Information in this report is current as of November 3, 1987.

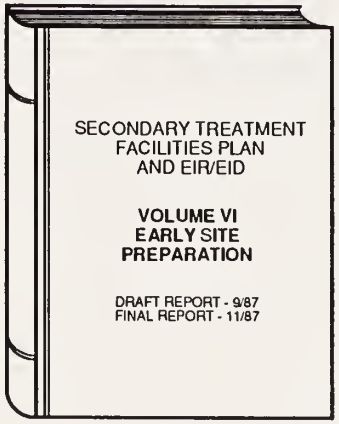
Daniel K. O'Brien
Acting Director
Engineering Division
November 3, 1987

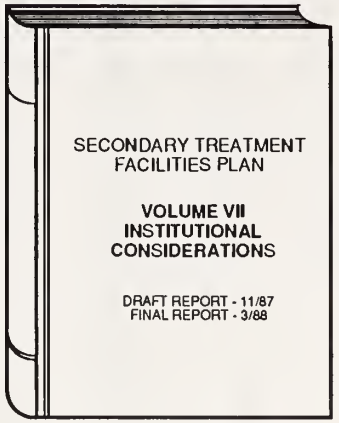





**MASSACHUSETTS WATER RESOURCES AUTHORITY**

# DEER ISLAND SECONDARY TREATMENT FACILITIES PLAN VOLUMES

## How to Use the Secondary Treatment Facilities Plan

The Secondary Treatment Facilities Plan is organized into seven volumes.

The major components of the Secondary Treatment Facilities Plan are: Treatment Plant, Inter-Island Transport System, Effluent Outfall, and Early Site Preparation.

The Secondary Treatment Facilities Plan document consists of a stand-alone volume for each of these components as well as volumes for Facilities Planning Background, Institutional Considerations, and Executive Summary.

Each volume may be referenced to find complete planning information pursuant to that project component. The seven volumes are numbered as follows:

| | |
|---|---|
| Volume I | Executive Summary |
| Volume II | Facilities Planning Background |
| Volume III | Treatment Plant |
| Volume IV | Inter-Island Transport System |
| Volume V | Effluent Outfall |
| Volume VI | Early Site Preparation |
| Volume VII | Institutional Considerations |

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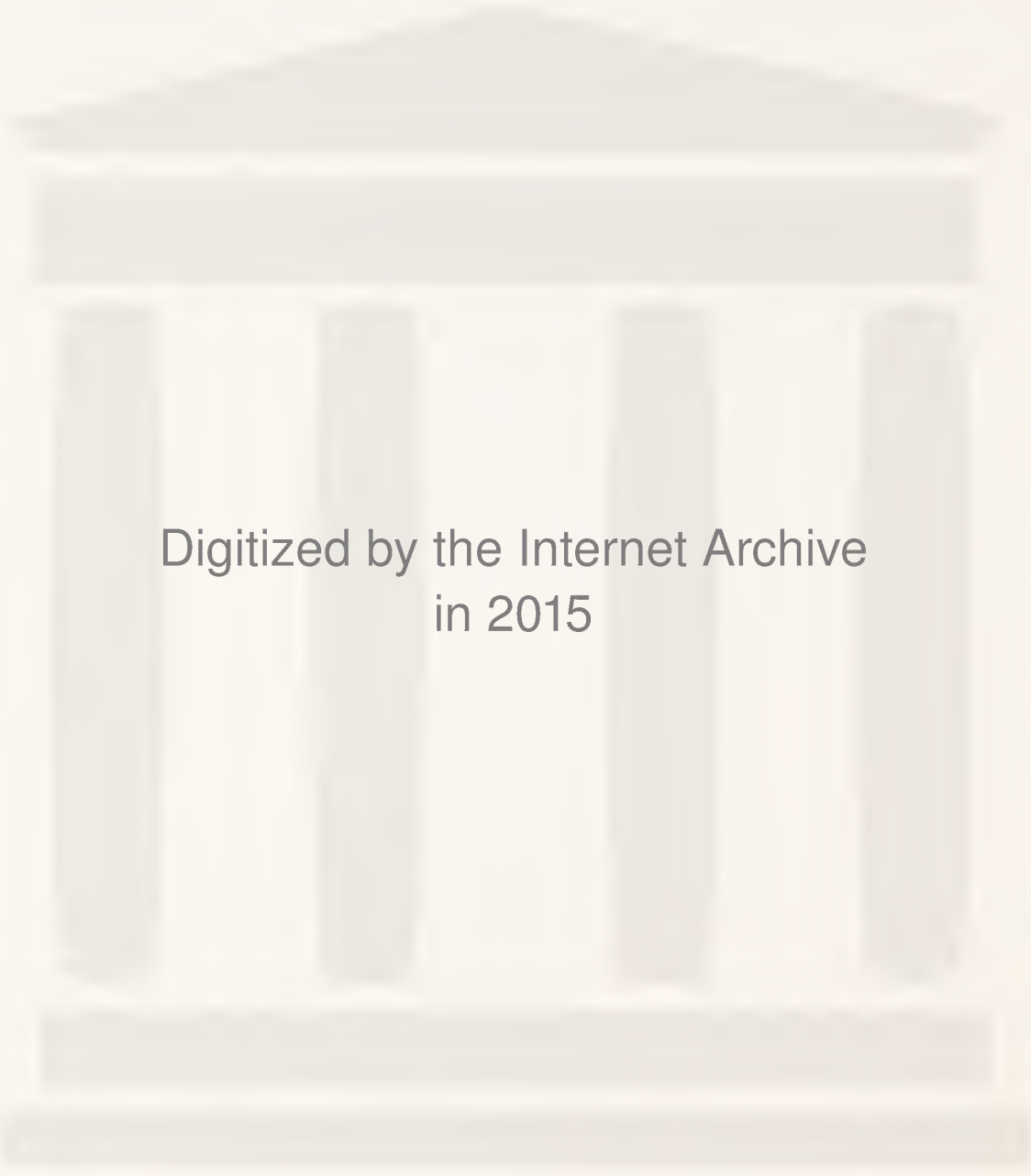
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# SECONDARY TREATMENT FACILITIES PLAN

## VOLUME III

## TREATMENT PLANT

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**November 3, 1987**


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# Section 1

# 1.0 SUMMARY

## 1.1 VOLUME IDENTIFICATION

This is Volume III, Treatment Plant, of the seven-volume Deer Island Secondary Treatment Facilities Plan.

## 1.2 INTRODUCTION

The existing Massachusetts Water Resources Authority (MWRA) wastewater collection system consists of a North System and a South System. Currently, wastewater from the South System is treated at the Nut Island Primary Treatment Plant and wastewater from the North System is treated at the Deer Island Primary Treatment Plant. New primary and secondary treatment facilities, which will serve both the North and South systems, will be constructed on Deer Island. The existing treatment facilities on Nut Island will be decommissioned following startup of the new primary facilities on Deer Island, and preliminary treatment, consisting of screening and grit removal, will be provided at a new headworks on Nut Island.

This volume presents the recommended treatment facilities on Deer Island and Nut Island and discusses the evaluation process leading to the recommendation. Also contained in this volume are the environmental impact assessment, cost estimates, and institutional considerations related to the treatment recommendations. The inter-island transport system to convey South System flows from Nut Island to Deer Island is described in Volume IV. The outfall to discharge treated effluent from the new Deer Island treatment facilities is described in Volume V.

This volume also contains background information common to several volumes of the Deer Island Secondary Treatment Facilities Plan. Included in this common background information are basic planning criteria, description of the existing MWRA treatment facilities, and projected wastewater flows and loads. The projected flows and loads used to size the recommended treatment facilities are presented in Table 1.2-1.

## 1.3 PLANT PERFORMANCE

The treatment plant performance and its effluent quality can be described in terms of two general categories: conventional pollutants and non-conventional pollutants. Conventional pollutants, defined as Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), are the parameters commonly used to define the needed level of wastewater treatment. Non-conventional pollutants include Priority Pollutants and Hazardous Substance List compounds. The required removal efficiency for conventional pollutants is defined by the NPDES permit as that required to meet national standards for secondary treatment. Desired removal efficiencies for conventional parameters establish the sizing of primary and secondary facilities. Once a degree of primary and secondary treatment is established, removals of the non-conventional pollutants can be estimated. Levels of removal of the non-conventional pollutants are not significantly controllable in primary and secondary treatment units.

## TABLE 1.2-1

## DESIGN YEAR (2020) FLOWS AND LOADS

| | LOW GROUNDWATER CONDITIONS | | | HIGH GROUNDWATER CONDITIONS | | |
|---|---|---|---|---|---|---|
| | Average Day | Maximum Day | Peak Hour | Average Day | Maximum Day | Peak Hour |
| NON-STORM CONDITIONS | | | | | | |
| Total Flow (mgd) | 390 | 600 | 750 | 670 | 950 | 1000 |
| STORM CONDITIONS | | | | | | |
| Wastewater Flow (mgd) | 390 | 600 | 750 | 670 | 950 | 1000 |
| Storm Capacity (mgd) | | 550 | 510 | | 320 | 270 |
| Total Flow (mgd) | | 1150 | 1260 | | 1270 | 1270 |

(Annual Average Flow is 480 mgd based on 4 months of high groundwater conditions and 8 months of low groundwater conditions.)

| | Loads (1000 lbs/day) | |
|---|---|---|
| | BOD | TSS |
| Average Day | 570 | 515 |
| Maximum Day | 1140 | 1080 |
| Maximum Three Days | 855 | 824 |
| Maximum Month | 741 | 670 |
| Maximum Day with Storm | 1305 | 1480 |

The secondary portion of the Deer Island treatment plant has been sized to treat flows up to a rate of 1080 mgd. Flow in excess of this, up to the total plant capacity of 1270 mgd, would receive primary treatment and be mixed, after screening to remove floatables, with the secondary effluent for subsequent disinfection and discharge to the outfall. The BOD and TSS concentration of the mixed effluent will meet required secondary discharge limits. Average annual effluent from the proposed secondary treatment plant is expected to be 15 mg/l BOD and TSS.

The NPDES permit also requires a minimum of 85 percent removal of both BOD and TSS based on monthly average values. This requirement may not be met under all circumstances. During high groundwater conditions, when the incoming wastewater is diluted, the projected monthly percent removals are estimated to be about 77 to 79 percent. Higher levels are not achievable without going beyond secondary treatment. The EPA's national policy allows for adjustment of the percent removal requirement provided that the effluent concentration limitations are met and that the dilution is not the result of excessive infiltration/inflow as defined by EPA rules and regulations. The MWRA's existing infiltration/inflow policy and program are focused on the EPA rules and regulations related to the elimination of excessive flows.

Removal rates for the non-conventional pollutants were estimated based on typical removal rates for metals and volatile organics at other secondary treatment plants. The volatile organics are removed at rates of 90 percent or greater in secondary treatment facilities. Projected removal efficiencies for fourteen metals detected in the MWRA raw wastewater vary from 5 percent for boron to 90 percent for silver. Typically, the efficiency of metals removal ranges from 50 to 75 percent, although the rate is quite variable for various metals.

## 1.4 EVALUATION OF ALTERNATIVE PROCESSES

Alternative unit processes for preliminary, primary, and secondary treatment as well as effluent disinfection were evaluated in a three-step process. The initial step consisted of a screening and preliminary evaluation of a wide range of alternatives. From this screening, a limited number of alternatives were retained for a detailed evaluation. Finally, recommended treatment facilities were selected, based on the detailed evaluation.

### 1.4.1 SCREENING AND PRELIMINARY EVALUATION OF ALTERNATIVES

Thirty-five unit processes were initially identified as potentially viable for either preliminary, primary, secondary, or disinfection treatment alternatives. The processes were selected after considering a wide range of conventional and state-of-the-art treatment alternatives. The processes identified were considered viable for initial preliminary evaluation and screening because of a demonstrated ability at large wastewater treatment plants to consistently meet treatment standards, and/or the flexibility to operate in various treatment modes under different hydraulic and loading conditions. Each unit process was evaluated on the basis of area requirements, operating history and performance at other large municipal wastewater treatment plants, relative capital and operating costs, and fourteen other screening criteria related to construction, operational, and environmental considerations.

The thirty-five individual unit processes evaluated during the preliminary evaluation and screening phase and the fifteen unit processes carried forward for detailed evaluation are presented in Table 1.4.1-1.

## 1.4.2 DETAILED EVALUATION OF ALTERNATIVES

Treatment processes retained from the screening evaluation for both the Deer Island secondary treatment facility and the Nut Island headworks were compared in a detailed evaluation using technical, environmental, institutional, and cost considerations. Site planning goals and mitigation commitments also influenced the selection of the recommended plan.

### Nut Island

Preliminary Treatment. To protect the inter-island transport system and the South System pumping station, preliminary treatment for the South System flows will be provided at the new Nut Island headworks. Climber screens are recommended for screening of influent wastewater at the new headworks, based on MWRA operational familiarity as well as operational and maintenance advantages over the catenary screen alternate. Centrifugal grit removal is recommended at Nut Island rather than aerated grit removal. Both types of grit removal are fully proven and the institutional impacts of each are nearly identical. However, the centrifugal grit removal alternative was selected because of lower capital and operating costs and reduced volume of air flow requiring air emissions control. Capital costs for the centrifugal system are 60 percent of the capital costs for the aerated grit removal system, and operating and maintenance costs for the centrifugal units are 80 percent of the O & M costs for the aerated grit units.

### Deer Island

The factors of primary concern in the selection of the recommended plan for Deer Island were unit process area requirements and site layout, together with operational reliability and flexibility. During the detailed evaluation phase, a concurrent review of the alternative unit processes, the site constraints, and the site planning objectives immediately revealed that minimizing the area required for each unit process was imperative. The most feasible and accommodating process option available to meet this requirement was the use of stacked rectangular clarifiers for both primary and secondary sedimentation.

Preliminary site layouts of the treatment plant on Deer Island indicated that the use of conventional rectangular clarifiers was not a viable alternative for either the primary or secondary treatment systems. The use of conventional, rectangular units would require commitment of the entire Deer Island site for process basins and would not allow space for separation berms, plant roadways, control buildings, and other ancillary facilities. Therefore, the use of stacked, rectangular clarifiers was the only alternative considered for both primary and secondary treatment.

**TABLE 1.4.1-1**
**SUMMARY OF SCREENING EVALUATION**

| UNIT PROCESSES EVALUATED | UNIT PROCESSES RETAINED FOR DETAILED ANALYSIS |
|---|---|
| **PRELIMINARY TREATMENT** | |
| Climber Bar Screens | Climber Bar Screens |
| Catenary Bar Screens | Catenary Bar Screens |
| Horizontal Flow Grit Channel | |
| Aerated Grit Chamber | Aerated Grit Chamber |
| Centrifugal Grit Chamber | Centrifugal Grit Chamber |
| Cyclone Primary Sludge Degritting | |
| Preaeration | |
| **PRIMARY TREATMENT** | |
| Rectangular Clarifiers | Rectangular Clarifiers |
| Circular Clarifiers | |
| Sedimentation with Chemical Addition | |
| Tray Clarifiers | |
| Stacked Clarifiers | Stacked Clarifiers |
| Inclined Tube Settlers | |
| **SECONDARY TREATMENT** | |
| Air Activated Sludge | Air Activated Sludge |
| Oxygen Activated Sludge | Oxygen Activated Sludge |
| Burns-McDonnell Treatment System | |
| Powdered Activated Carbon | |
| Deep Shaft Activated Sludge | |
| Sequencing Batch Reactor | |
| Rotating Biological Contactor | |
| Trickling Filter | |
| Biological Filtration | |
| Coupled System | Coupled System |
| Pulsed-Bed Filtration | |
| Physical-Chemical Treatment | |
| Rectangular Clarifiers | Rectangular Clarifiers |
| Circular Clarifiers | |
| High Rate Clarifiers Followed by Filtration or Microscreens | |
| Tray Clarifiers | |
| Stacked Clarifiers | Stacked Clarifiers |
| Screening (for primary effluent) | Screening (for primary effluent) |
| **DISINFECTION** | |
| Liquid Chlorine | |
| Soldium Hypochlorite | Sodium Hypochlorite (purchased on-site or off-site generation) |
| Ozone | Ozone (only with oxygen activated sludge.) |
| Ultraviolet Irradiation | Ultraviolet Irradiation |

Preliminary Treatment. The grit and screening removal equipment at the three existing North System remote headworks, currently being upgraded as part of the Fast-Track Improvements Program, will adequately protect the conveyance system and raw wastewater pumps throughout the planning period. However, as evidenced by grit buildup at the existing Deer Island plant, additional grit removal is required to protect the new treatment facilities. This additional grit removal for the North System flows will be provided by new grit facilities on Deer Island operating in series with the existing remote facilities. For reasons previously described in the section on Nut Island facilities, centrifugal grit removal is also recommended for the new Deer Island grit removal facilities.

Primary Treatment. The use of stacked rectangular clarifiers is recommended for primary treatment as it will allow compliance with site development goals established within the Facilities Planning process. To date, stacked, rectangular clarifiers have not been used in the United States. However, various configurations of the units have been used in both primary and secondary treatment applications in Japan for over a decade. Over 37 Japanese plants now use them, including 8 plants with an average flow over 100 mgd. The Japanese installations produce effluents equal to or better than the conventional rectangular clarifier units.

Secondary Treatment. The three alternatives evaluated for secondary treatment -- air activated sludge, oxygen activated sludge and the coupled system (packed tower followed by activated sludge) -- have similar capital, operating, and life cycle costs. Of the three alternatives, the coupled system has the greatest capital costs, operation costs, and power consumption.

The three alternatives can also be considered equal regarding potential noise impacts on neighboring homes, constructibility, effluent quality, and residual quantity and quality. The air and oxygen activated sludge systems can be considered equal with regard to area requirements, while the coupled system is slightly more area-intensive.

Operationally, the coupled system is slightly more complex, as the process requires control of two biological systems. The coupled system offered no distinct advantage over the activated sludge alternatives, and since it also had the highest costs and power consumption, it was eliminated from further consideration during the detailed evaluation of alternatives. Thus, the activated sludge process utilizing stacked, rectangular clarifiers was selected for the secondary treatment component of the Deer Island treatment facilities. Alternative methods of providing oxygen to support biological stabilization in the activated sludge process were evaluated. Oxygen can be provided by air, or it can be generated on-site in a cryogenic oxygen generation unit. Either air or oxygen activated sludge would produce the desired plant performance.

The secondary treatment plant at Deer Island will be subjected to highly variable flows and loads due to the nature of the MWRA collection system. The ability to successfully maintain effluent quality under these variable conditions was an important parameter in selecting between air and oxygen for the activated sludge process. Oxygen activated sludge systems have an inherently greater capability to handle large variations in loadings than do air activated sludge systems. Operating oxygen activated sludge systems handling large variations in organic loads, flows, and chloride concentrations have demonstrated operating resiliency and

considerable ability to maintain effluent quality. Oxygen systems have a proven track record in successfully handling large variations in organic loadings and have a clear advantage over air systems in this regard.

Additionally, there is significantly less process equipment and fewer components associated with the oxygen activated sludge system than are needed for the air activated sludge system. Most importantly, the air activated sludge system would contain over 100,000 fine bubble diffusers to entrain air into the wastewater. The success of the air activated sludge process is critically dependent on monitoring and maintaining the efficiency of these fine bubble diffusers. Monitoring and maintenance to comply with air quality regulations would be highly problematic with the covered aeration basins required at the new Deer Island secondary treatment facilities. Any maintenance on the fine bubble air diffusers and associated piping would require operator entrance into the covered basins. In contrast, the oxygen system utilizes mechanical aerators that can be maintained from the top of the covered oxygen basins by lifting the aerators with a mobile crane. Oxygen system operators report that maintenance personnel are seldom, if ever, required to enter the covered oxygen basins. The MWRA Secondary Treatment Facilities Plan Operations Review Committee unanimously agreed that, with covered aeration basins, an oxygen activated sludge system would be preferred over air activated sludge.

Given the level of equipment that must be maintained in each system, the operational complexity associated with the covered aeration basins in the air activated sludge system, and the superior operational flexibility and reliability offered by the oxygen system, the oxygen activated sludge system is preferred from an overall operability standpoint.

All of the off-gases from the activated sludge process must be collected and treated to reduce odors, VOCs and other pollutants of public health concern. The collection and treatment of these gases is much more easily achieved in the oxygen activated sludge system than in the air system as the small quantities of off-gases from an oxygen system create an ideal situation for the application of emission treatment and control. Peak and average air flows for the air system are 280,000 scfm and 120,000 scfm, respectively. Corresponding values for the oxygen system are 6,000 and 3,000 scfm. Air emissions standards, particularly for air toxics, are in a state of flux. The oxygen activated sludge alternative, which generates only 2 percent of the vent air produced by air activated sludge, requires the least amount of control and offers significant advantages over the air system.

During the detailed evaluation phase, the use of an anaerobic selector basin, prior to the aeration basin, was also evaluated for both the air and oxygen activated sludge alternatives. For both alternates the anaerobic selector basin provides for both alternate added stability and reliability under varying loading conditions and produces a better settling sludge, allowing for a decrease in secondary clarifier sizing.

Based on the above, pure oxygen activated sludge, using cryogenic generation of the oxygen, with stacked, rectangular secondary clarifiers, is the recommended secondary component of the Deer Island treatment facilities. This selection was based on the ability of oxygen to efficiently treat highly variable loads without process upset, as well as its overall

operability and lower air emission control requirements. An anaerobic selector, employed prior to the oxygen aeration basins, is recommended as part of the secondary treatment components. The benefits associated with the selector, including increased stability under varying loading rates, and a potential reduction in overall oxygen requirements and improved sludge settleability, warrant its inclusion.

Disinfection. The alternatives evaluated for disinfecting the Deer Island effluent were sodium hypochlorite (purchased or generated on-site), ozone, and ultraviolet irradiation. Dechlorination with either sulfur dioxide or sodium bisulfite was included with the hypochlorite alternatives. Between the 1995 start-up of the primary facilities and the 1999 start-up of the secondary facilities effective disinfection of primary effluent is required. Sodium hypochlorite is the only alternative which would provide adequate disinfection under these circumstances. Therefore, to implement ozone or ultraviolet irradiation as a disinfectant would require an interim sodium hypochlorite disinfection process between 1995 and 1999. Ozone is a questionable disinfectant for secondary effluents which exceed 30 mg/l TSS and BOD, such as those effluents that occur during maximum flow conditions at Deer Island. Ozone was eliminated from further consideration on the basis of this factor as well as its failure to offer any cost advantages.

Purchased sodium hypochlorite is preferred over ultraviolet irradiation even if subsequent water quality determination indicates that dechlorination procedures are required. The selection was primarily based on the present worth analysis which determined the present worth cost of the UV system to be 1.4 times the cost of the sodium hypochlorite system.

A comparison of the sodium hypochlorite alternatives - purchase versus on-site generation - indicated that purchased sodium hypochlorite was a much more desirable alternative due to capital cost, operability, and power and staffing requirements.

The recommended plan for disinfection is to use purchased sodium hypochlorite and if dechlorination is necessary, to use sodium metabisulfite.

Control of Air Emissions

The emissions of odor-causing compounds volatile organic compounds and other pollutants of public health concern from the proposed treatment facilities are controlled under federal, state, and local regulations. The control of odors was also addressed as a required mitigation measure in the Secretary's Certificate on the Siting EIR. The mitigation standard requires that there be no detectable odor when one part ambient air is diluted in one part of odor-free air at the property line of the treatment plant. This requires the Authority to design the new treatment facilities to eliminate off-site odors.

The Massachusetts Air Pollution Control Regulations require that all new or modified sources of air pollutants apply the Best Available Control Technology (BACT) to control volatile organic compounds (VOC) discharges. BACT is not specifically defined, but requires a case-by-case assessment taking into account energy, environmental, and economic impacts.

A modification to a source currently emitting more than 100 tons per year of VOCs must meet Lowest Achievable Emission Rate (LAER) requirements if it is determined that, after the application of BACT, the proposed increase above the baseline condition would be greater than or equal to 40 tons per year. Since the Boston area does not meet the National Ambient Air Quality Standards (NAAQS) for ozone, any emission increase above the baseline after LAER control would also have to be offset by obtaining an equal reduction, plus an additional ten percent reduction, in the level of VOC emissions from an existing source.

Emission of individual constituents with public health significance are limited by the Allowable Ambient Levels (AAL) standards set by the Department of Environmental Quality Engineering (DEQE). Pollutants of public health concern include about 150 compounds from EPA's Priority Pollutant List (PPL) and Hazardous Substance List (HSL). The AALs developed by DEQE for these pollutants represent the maximum allowable 24-hour incremental ambient impacts from proposed facilities. Compliance with the AALs requires that the calculated ambient increase in concentration be less than the AAL at all locations of public access beyond the fence line of the treatment facilities.

Odor-causing compounds, VOCs and PPL/HSL pollutants can be emitted from treatment process units wherever interfaces exist between the wastewater and air. These interfaces exist at tank surfaces, channels, weirs, and aeration tanks. Recommended treatment facilities which have the potential to emit these pollutants in sufficient amounts to impact ambient air levels include the:

- Grit Removal Facilities
- Primary and Secondary Splitter Boxes
- Primary Clarifiers
- Anaerobic Selectors
- Aeration Basins
- Secondary Clarifiers
- Disinfection Basins

Emissions from these process units were estimated and used in air-quality modeling to assess the impact on ambient air quality. The first analysis considered odor-causing compounds and VOCs. The effectiveness of air emission control on PPL/HSL pollutants was then determined.

Both the existing Deer Island and Nut Island Treatment Plants emit in excess of 100 tons per year of VOCs. In order to prevent the uncontrolled release of air pollutants, the proposed treatment facilities will include covers. VOC emission estimates indicated that all tanks up to and including the aeration basins should be covered. Covers are not required on the secondary clarifiers and the disinfection basins. Air from the covered facilities will be collected and conveyed to odor/VOC control systems prior to discharge to the atmosphere.

A comparison of BACT controlled emission rates to existing annual VOC emissions resulted in net reductions for both the Deer and Nut Island baseline levels indicating that BACT levels of emission control, not LAER levels, are required.

Alternative systems evaluated for emission control included ozonation, wet scrubbing using caustic soda and hypochlorite, carbon adsorption, and fume incineration. Of these, the most reliable control system for both odors and VOCs is wet scrubbing followed by carbon adsorption. Wet scrubbing would be used to remove odor-causing compounds and carbon adsorption would be used to remove residual hydrogen sulfide and VOCs. Overall, removal efficiency for the system is estimated to be 95 to 99 percent for sulfide and 85 percent for VOCs.

Air quality modeling of the potential, emissions from the recommended facilities indicated that the constituents released from the treatment system after emission control will be much less than the critical AAL levels measured at the boundaries of Deer Island. The recommended facilities will have insignificant impacts on the local populations in terms of ambient air quality. Recommended covers and emission control systems result in impacts on surrounding populations that are within allowable air quality limitations even under worst-case scenarios. No odors associated with the liquid wastewater treatment facilities will be detected off-site. The recommended emission control systems are in full compliance with the provisions of BACT as required by the DEQE.

## 1.5 RECOMMENDED PLAN

The recommended plan for the MWRA treatment facilities consists of the following major components:

Preliminary Treatment

- Screening and grit removal at existing North System remote headworks.
- Screening at Winthrop Terminal.
- Additional grit removal of North System flow at new grit facilities on Deer Island.
- Screening and grit removal of South System flow at new Nut Island headworks.

Wastewater Pumping

- Replacement and modification of existing pumps at the North Main Pumping Station and the Winthrop Terminal to allow discharge to the new treatment facilities.
- Pumping of the South System flow at a new South System Pumping Station on Deer Island.

Primary and Secondary Treatment

- Primary treatment to a flow rate of 1270 mgd in stacked rectangular clarifiers arranged in four batteries.
- Secondary treatment to a flow rate of 1080 mgd in four parallel batteries of sequentially arranged anaerobic selectors, aeration basins and stacked rectangular clarifiers.
- Oxygen generation with two 300 ton per day cryogenic units.
- Fine screening of primary effluent in excess of 1080 mgd with traveling water screens.

Disinfection

- o Disinfection with barge-delivered sodium hypochlorite in chlorine contact basins, with dechlorination, if required, accomplished using sodium metabisulfite.

The sequence of treatment is presented schematically in Figure 1.5-1.

All of the treatment units except the secondary clarifiers and disinfection contact basins will be covered. Exhaust air from the covered treatment units, and from pumping station wet wells and wet shafts, will be collected and treated with wet scrubbers (using sodium hypochlorite and caustic soda) followed by carbon adsorption.

During treatment of the wastewaters, residuals, including screenings, skimmings, grit, primary sludge, and secondary sludge, will be produced. Removal points from the treatment facilities are indicated in the treatment schematic shown in Figure 1.5-1. Handling, treatment, and disposal of these residuals is being addressed in the MWRA's Residuals Management Facilities Plan. Projected average quantities of residuals are presented below.

**SUMMARY OF AVERAGE RESIDUAL PRODUCTION**

| | Remote Headworks | Deer Island | Nut Island |
|---|---|---|---|
| Grit (cubic yards per day) | 4 to 6 | 30 to 32 | 11 |
| Screening (cubic yards per day) | 14 | 2 | 11 |
| Skimmings (cubic yards per day) | -- | 70 | -- |
| Primary Sludge (dry tons per day) | -- | 168 | -- |
| Secondary Sludge (dry tons per day) | -- | 140 | -- |

## 1.5.1 SITE LAYOUTS

### Nut Island

The recommended layout for the new Nut Island headworks locates the facility at the site presently occupied by the existing anaerobic digesters. The site will be available once the MWRA's interim solids disposal program is in place by 1991. The headworks facility consists of a headworks building and grit removal facilities. The most visible component of the facility will be the headworks building which houses the screening facilities, truck loading bays, air emissions control facilities, administrative, operation, employee and maintenance areas. This building covers approximately 19,000 $ft^2$ and is 20 ft high. The existing grade at the selected site is approximately 131 ft while the final grade at the site will be approximately 128 ft. The grit chambers are located below grade, adjacent to the headworks building, and cover an overall area of approximately 22,000 $ft^2$. The inter-island tunnel shaft is located to the south of the grit chambers.

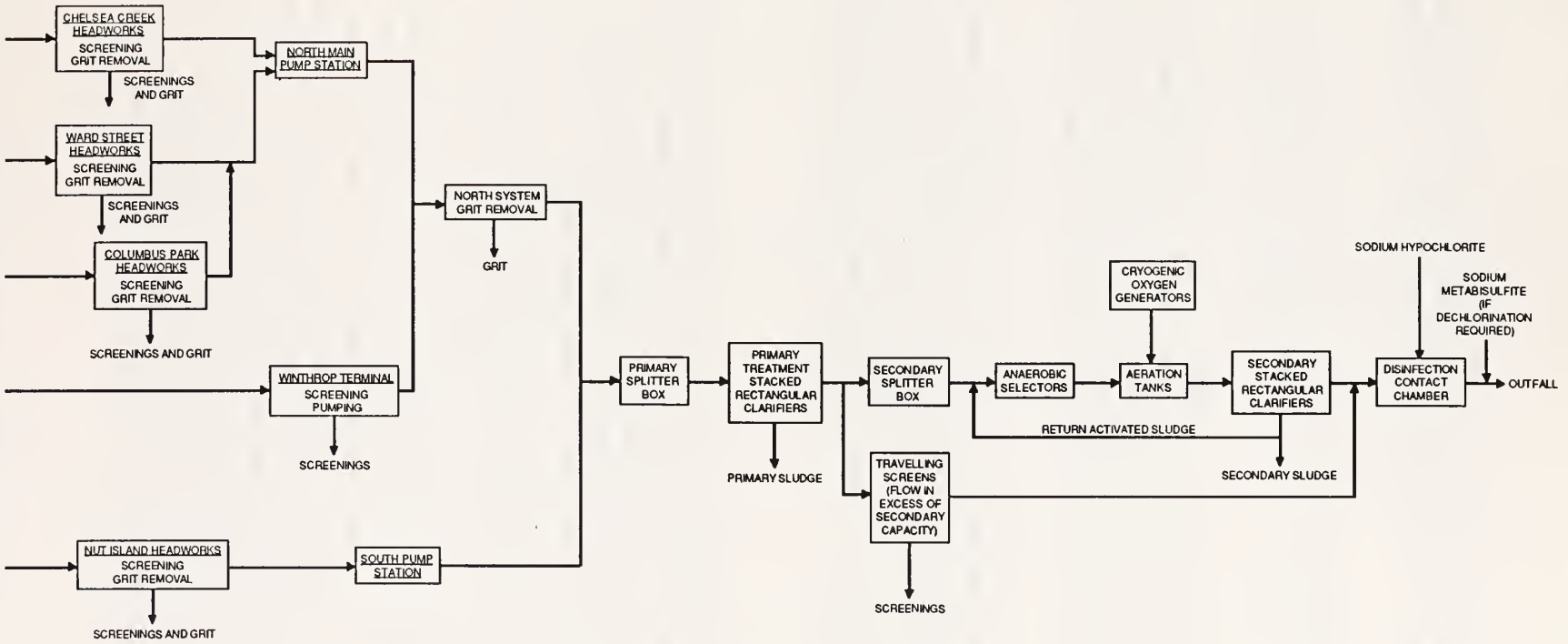


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**FIGURE 1.5-1**
**SCHEMATIC - RECOMMENDED MWRA TREATMENT FACILITIES**

Access to the headworks facility is by either the existing main access road along the western side of the island, or the pier to be constructed at the northeast end of the island. The roadways on the island are arranged to provide safe traffic patterns for all vehicles, and allow fluid movement of the trucks serving the headworks facility.

The site plan for Nut Island allows for safe, shared use for wastewater treatment and passive recreation. Areas designated for wastewater treatment facilities are separated from the remainder of the island by fences and earth berms.

The portions of the site that have not been designated for wastewater treatment purposes are planned as open space for passive recreation. Landforms and vegetation on the island promote this use. This concept is consistent with the City of Quincy's land use zoning classification. A pedestrian path encircles the island, providing continuous views of Boston Harbor and Quincy and Hingham Bays, as well as convenient access to most of the island including the beach on the eastern shore.

Proposed landscaping on the island is functional, while at the same time creating a natural visual image. Earth berms up to elevation 140 ft are formed around and against the wall of the headworks building and grit chambers. The berms, trees and shrubs are arranged to visually screen the headworks facilities -- primarily from Hough's Neck, but also from points across Quincy Bay and from the pedestrian path encircling the island. An architectural site plan of the developed Nut Island site is presented in Figure 1.5.1-1.

Deer Island

The Deer Island site plan consists of four interrelated parts - the buffering landforms, the treatment facilities, the support facilities, and the residual management facilities. These parts are tied together by an external access system consisting of roadways, piers, and service roads and an internal access system consisting of passageways, pipe galleries, and stairwells. Each of the parts has its own distinct visual image - the landforms are gently sloped earthen and vegetated hills, and the treatment facilities are large massings of concrete basins. These parts have been assembled so that the concrete treatment facilities occupy the central portion of the site, the brick faced support facilities occupy the adjacent area on the western, southern and eastern side of the treatment facilities, and the landforms occupy the outermost portion of the site and effectively conceal the treatment facilities and support facilities on the northern, eastern and western sides of the site. The appearance of the recommended facilities to a viewer will depend upon the viewer's location. Within the landform areas on the outer edge of the site, the visual image will generally be of the earthen vegetated hillsides. This image will also be seen by distant viewers, particularly those to the north and east of the site. The view from the external access roadway located between the western landforms and the treatment facilities will be of the brick faced support facilities backdropped by the concrete walls of the basins, with earth landforms rising around the horizon. From the treatment facilities, the view will consist of a large expanse of covered and uncovered basins surrounded by support buildings which are backdropped by the earthen

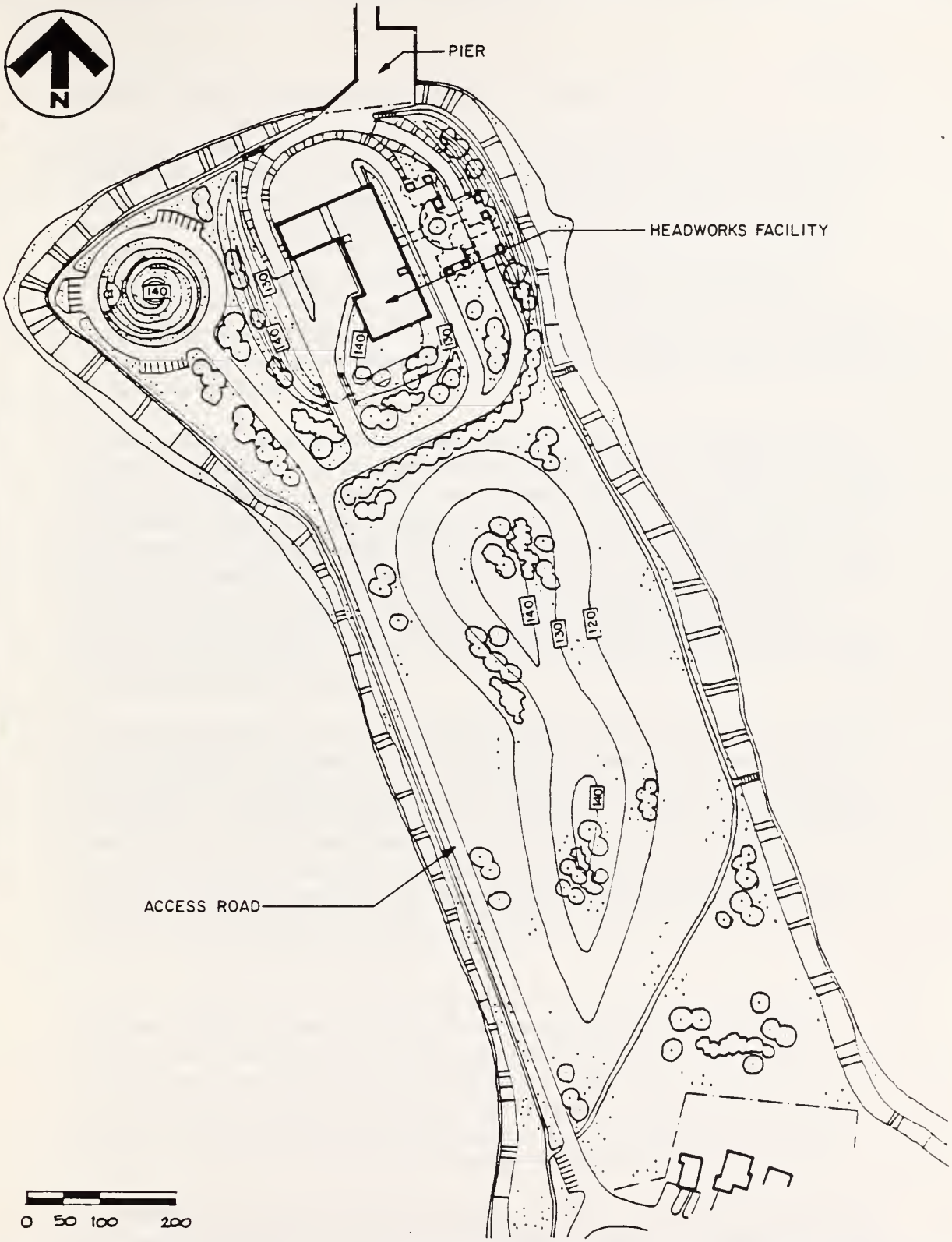


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**FIGURE 1.5.1-1**
**NUT ISLAND SITE PLAN**

landforms. The recommended site layout is shown in Figure 1.5.1-2.

Vertically, the design of the site is organized around two distinct zones. The lower/access zone is at an approximate elevation of 120 to 130 ft and is the level at which the piers, access roadways, internal passageways, and the ground floor of the support buildings are located. The upper/facilities zone at elevations 145 to 155 ft is the level at which the tops of basins, air emission control facilities, operation buildings, and service roadways are located. Within the facilities, air emission exhaust stacks, potable water storage tank, oxygen plant distillation columns, and power plant exhaust stacks create vertical spikes rising to elevations between approximately 200 to 230 ft. Around the facilities the landforms rise to elevations ranging from approximately 180 to 220 ft and are connected by ridges with elevations of approximately 150 ft.

The main process area of the liquid treatment facilities is aligned in a rectangular grid on a generally south-to-north axis, extending from approximately the southern edge of the existing drumlin and proceeding northward to the area currently occupied by the Hill Prison structure. The southern portion of the main process area consists of primary treatment facilities, the central portion is dedicated to the anaerobic selector basins and the aeration basins, and the northern end consists of the secondary clarifiers. The plant is subdivided within each of the primary and secondary treatment areas into four equal sized batteries, with each of the batteries containing multiple basins. Residuals handling facilities (per the Residuals Management Facilities Plan) will be located in the area between the liquid treatment facilities and the southern tip of the island.

The support facilities have been located along the western, southern and eastern side of the plan as independent, brick faced structures with either connecting tunnels, passageways, or bridges to the main treatment structure. The majority of the support facilities including the power facilities, North Main Pumping Station, maintenance, warehousing, administration and laboratory operations have been located along the western side of the treatment facilities. On the southern side of the treatment facilities have been located the primary facilities operations management center, the grit handling facilities, and the South System Pumping Station. On the eastern side of the treatment facilities are located the oxygen generation plant and the primary effluent screening structure.

As shown in Figure 1.5.1-3, access to Deer Island will be both overwater and overland. Overwater traffic will unload and be controlled at the proposed new pier facilities. A vehicular access road along the western side of the treatment facility will connect the pier to the administration building, the treatment facility lower zone, maintenance facilities, and residual facilities. The vehicular access road will be ramped up to the northern end of the facilities, and on the western side at the maintenance buildings adjacent to the secondary clarifiers. The service roads completely surround and access the upper facilities zone.

An overland vehicular access road will connect Point Shirley to Deer Island. This road will have controlled access at two points. One of the control points will be a fenced gate at the property line, adjacent to Point Shirley and the northernmost outer berm. The second control

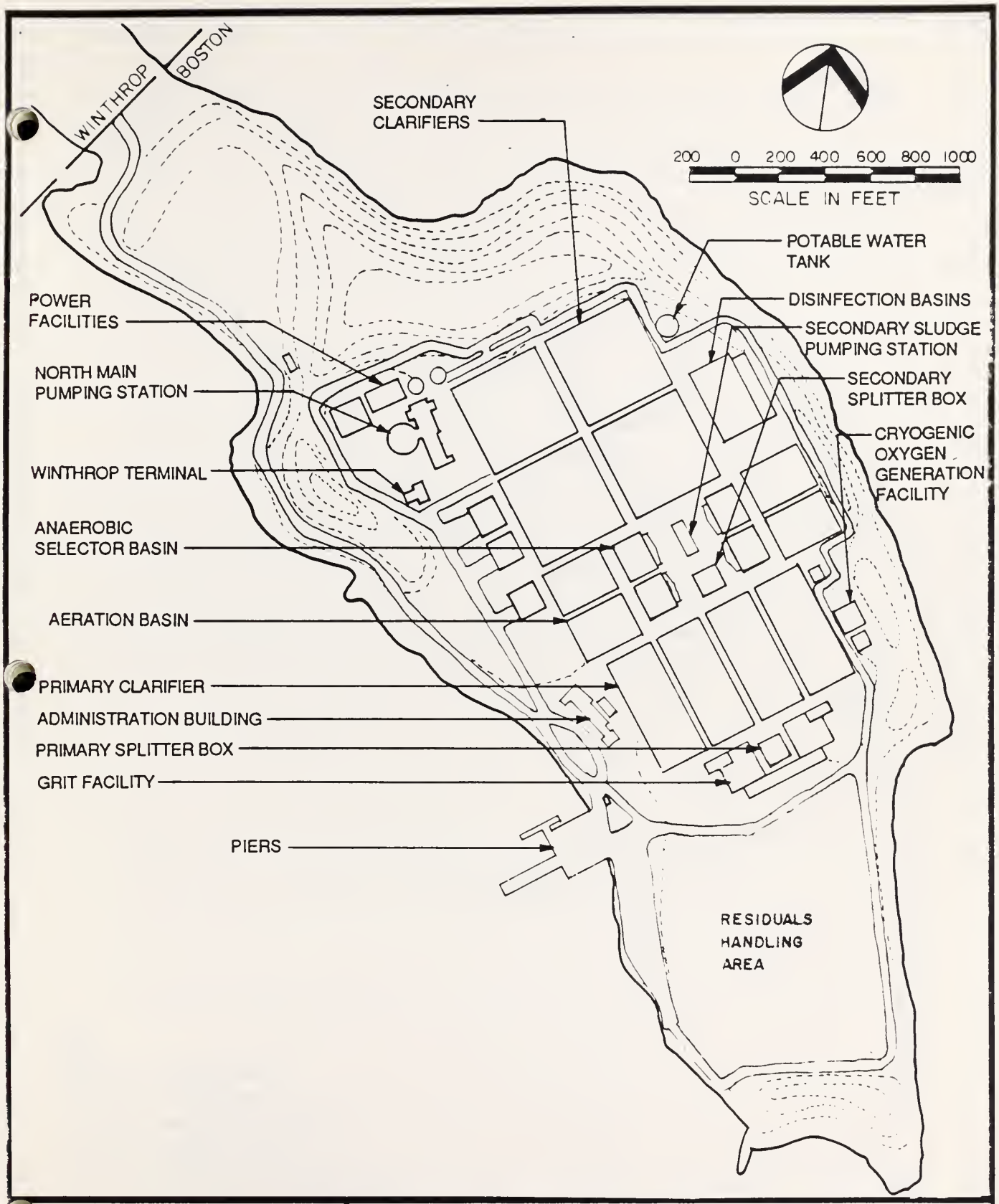


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**FIGURE 1.5.1-2**
**RECOMMENDED DEER ISLAND FACILITIES**

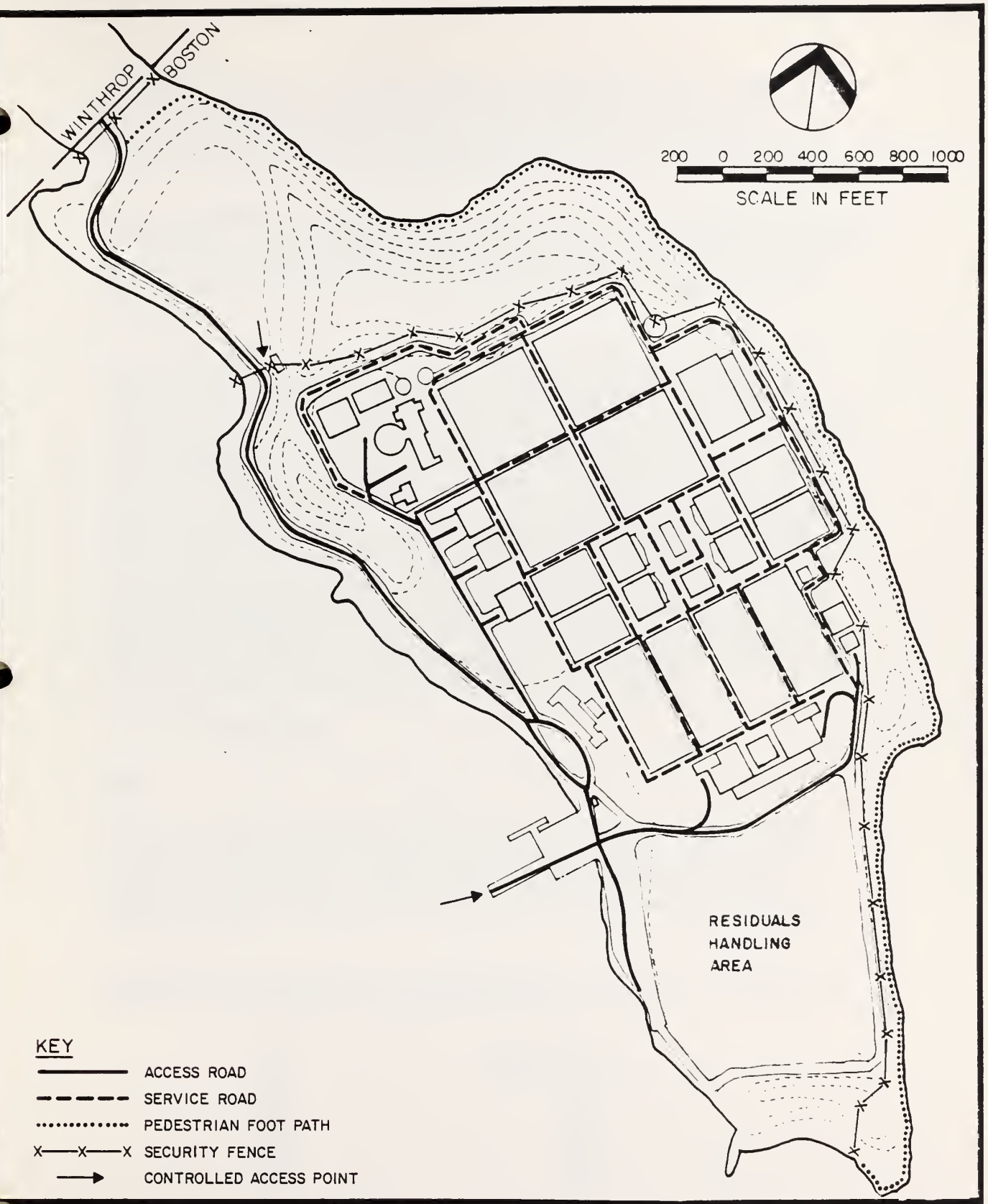


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**FIGURE 1.5.1-3**
**DEER ISLAND EXTERNAL ACCESS**

point will be the entrance to the treatment facilities at the inner limit of the separation zone. This overland access roadway follows the western shoreline to the area of the administration building. This roadway alignment directs visitors from the overland access routes to the same common point, the administration building, as the overwater access routes.

Within the separation zone, north and east of the plant, construction of a pedestrian footpath is contemplated. It would commence at the northern gate near the man-made drumlin and follow the northeastern shoreline of Deer Island to its southernmost tip. A control fence located at the inland foot of the landforms will prevent pedestrians from entering into the treatment plant areas.

The internal circulation system for the lower/access zone is as shown on Figure 1.5.1-4. Within the treatment facilities are numerous pipe galleries that have been configured to provide the plant with connected passageways between the various process elements. The main internal passageway runs from the pier area northward through the treatment facility. Main east-west passageways run at right angles to the north-south passageways in three locations: the east-west passageway between the primary clarifiers and aeration basins connects to the administration building and the primary effluent screening building; the east-west passageway between the aeration basins and the secondary clarifiers connects the vehicle maintenance building, secondary operations center, return activated sludge pump station, and plant water pump station; and the east-west passageway between the batteries of secondary clarifiers connects the maintenance and parts storage facilities to the internal access system. Minor passageways and pipe galleries would be located between process batteries as necessary for equipment access. Egress and ventilation shafts from the passageways are typically located at the ends and midpoints of the primary and secondary clarifiers batteries.

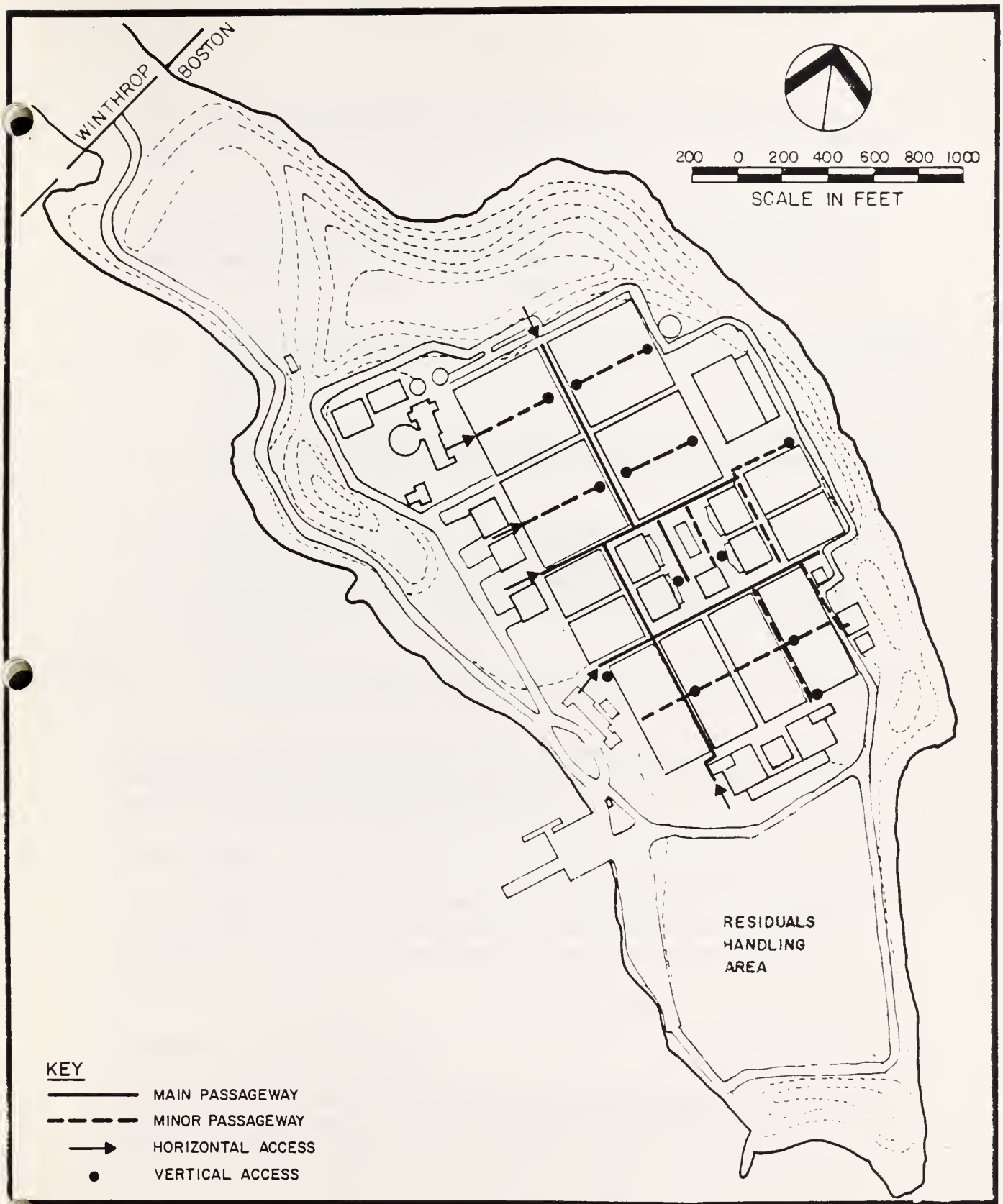
## 1.5.2 PLANT UTILITIES

### Power

Currently no public electrical utility services the Deer Island wastewater treatment facility. All electrical energy presently required at Deer Island is generated on-site by five, 700 kw diesel engine driven generators. Additional deisel engine-driven generators are being installed as part of the fast-track improvements to meet present day demands and should be operational by 1988.

The estimated average electric power requirements for the various phases of construction and operation of the treatment facility are summarized below:

| Year | Average Load (kw) |
|---|---|
| 1990 | 14650 |
| 1991 | 18650 |
| 1995 | 24050 |
| 1999 | 36800 |




MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 1.5.1-4**
**DEER ISLAND INTERNAL ACCESS**

To meet these demands a combination of on-site generation and off-site supply from Boston Edison Company (BECo) were evaluated using technical, economic, and environmental evaluation criteria.

The recommendation to provide sufficient, reliable power to Deer Island in all phases of construction and operation consists of the installation of a temporary power supply cable, followed by the installation of two 115 kv feeder cables and a combined cycle power plant. A summary of the recommended power plan is as follows:

- Install a temporary power supply cable by 1990 or sooner. Provide 15 Mw of immediate power through Massachusetts Electric Company (MECo) from its Metcalf Square Substation in Winthrop.

- Install a 115 kv permanent feeder from Boston Edison's K Street substation in South Boston, by January 1992. Placing the feeder in service requires the installation of a 115 kv to 13.8 kv substation on Deer Island.

- Install an on-island 25,700 kw combined cycle power plant by January 1995 to provide additional capacity for peak shaving and provide protection against catastrophic failure of the off-site power sources. This additional capacity combined with the soon-to-be-installed fast track capacity, will result in an installed on-site capacity of 37,700 kw.

- Install the second Boston Edison 115 kv permanent feeder by January 1995. This feeder will originate from BECo's Chelsea substation.

On-site sludge digestion and its associated costs and benefits are being studied as part of the Residuals Management Facilities Plan. On-site digestion would produce methane gas which can be used as a fuel in the on-site power generation facilities.

Heating Demand

The heating demand at the Deer Island treatment facilities will increase as new wastewater treatment facilities are constructed. The expected total yearly heat load, based on seasonal steam demand per degree days, has been estimated at approximately 86,000 million Btu.

Heat will be extracted as steam from the combined cycle power plant.

Potable Water and Plant Water System

Potable water needs for the new Deer Island wastewater treatment facilities were estimated and contrasted with existing water availability, and alternative approaches to support Deer Island's water supply needs were evaluated.

Potable water is presently used at the wastewater treatment facility for toilets, sinks, drinking fountains, sludge heaters, engine cooling, equipment flushing and washdown, and seal water. This water is supplied from the Winthrop water distribution system. Current average and maximum consumption rates are 0.1 mgd and 0.2 mgd, respectively. Water use will increase when the plant is upgraded to an average daily consumption of 1.0 mgd and a maximum daily consumption of 2.0 mgd.

Potable water required by the new Deer Island facilities cannot be supplied through Winthrop's existing distribution system due to the limitations in the system. A water supply study concluded that Deer Island potable water needs are best met by constructing a dedicated 20-in-diameter main through Winthrop to Deer Island.

The recommended plan provides for a 1.54 million gallon on-site storage of potable water at Deer Island in order to dampen the effects of diurnal flowrate variations, to provide adequate pressure for firefighting, and to provide a source of water in the event of a break in the dedicated main.

In order to minimize the consumption of potable water, the recommended Deer Island facilities are designed to reuse primary and/or secondary effluent for those purposes which do not require potable quality water. Non-potable water is designated "plant water", and will be used as necessary for engine cooling, process equipment flushing and equipment washdown. Plant water will be provided by a 45 mgd (31,250 gpm) plant water pumping station discharging directly to the plant water distribution system.

### 1.5.3 ESTIMATED COSTS

Capital Cost

The estimated project cost for the recommended treatment facilities is approximately $1.325 billion dollars. These costs include the inter-island conveyance tunnel from Nut Island to Deer Island and the South System Pumping Station. Costs for the effluent outfall facilities and residuals handling facilities, however, are not included. The breakdown of the estimated costs is as follows:

| | Cost in Millions |
|---|---|
| Nut Island Headworks and Site Restoration | $38 |
| Inter-Island Tunnel | 84 |
| South System Pumping Station | 40 |
| North Main Pumping Station, Winthrop Terminal and North Grit Removal Facilities | 71 |
| Primary Treatment Facilities | 241 |
| Secondary Treatment Facilities | 551 |
| Disinfection Facilities | 22 |

| | |
|---|---|
| Power Generation and Distribution | 103 |
| Site Work | 109 |
| Potable and Plant Water Systems | 19 |
| Administration, Maintenance and Control Buildings and Facilities | 47 |
| TOTAL | $1,325 |

These costs reflect September 1987 prices (ENR cost index of 4440) and include capital construction costs plus an allowance of 35% for engineering and contingencies.

Operation and Maintenance Costs

The annual operating cost following completion of all the recommended facilities in the year 2000 is estimated to be $32 million dollars.

The annual estimated operating costs for 1995, when only the primary treatment facilities are on-line, are $23 million. These costs reflect September 1987 prices. Operation and Maintenance costs for residuals handling are not included.

## 1.5.4 CONSTRUCTION CONSIDERATIONS AND SCHEDULE

Maintenance of Plant Operations

The existing treatment facilities on Nut Island and Deer Island must remain operational during the construction of the new facilities, until the new primary treatment facilities on Deer Island are completed and ready for service.

The existing Nut Island treatment facilities, except for the anaerobic digesters, will remain fully operational while the new headworks facilities are being constructed. The anaerobic digesters will be removed from service and demolished once the Nut Island interim solids disposal facilities are operational by December, 1991. The new headworks facilities will be constructed on the site of the existing digesters, with minimal interference with the operations of the Nut Island treatment facilities. Following completion of the new Deer Island primary treatment facilities and the inter-island transport system, the new headworks will be connnected to the High Level Sewer. Once the new primary facilities on Deer Island are operational and ready to receive flows from the South System, the existing Nut Island treatment facilities will be decommissioned.

The new Deer Island primary treatment facilities will be constructed to the south of the existing primary facilities at the southern edge of the existing drumlin. The existing primary treatment facilities will remain in use until the new primary treatment facilities are operational. At that time, the existing facilities will be decommissioned. The new secondary facilities will be constructed in the area of the existing Deer Island plant. During construction of the new primary facilities, connections will be made to the North Main Pumping Station and the Winthrop Terminal that will allow these facilities to discharge to either the

existing primary or to new primary treatment facilities. These connections will allow controlled flows to the new facilities during startup and testing. Construction of the connections to the North Main Pumping Station will result in reduced pumping capacity (5 of 10 pumps available) for several days or a few months depending upon the selected plan for making the connections. The plan with the shorter duration will cost in excess of an additional three million dollars. Construction of the connection from the Winthrop Terminal will result in the pumping capacity being reduced from 125 mgd to between 90 and 95 mgd for about a 60-day period.

Construction Scheduling

The construction scheduling for the new treatment facilities is summmarized in this volume and presented in detail in Volume VII, Institutional Considerations. Construction of the recommended facilities will occur over the period from 1988-2000. The various components of the recommended plan will be constructed according to the following schedule:

| | | |
|---|---|---|
| o | Early site preparation | 1988-1991 |
| o | Immediate but Interim Power | 1988-1990 |
| o | Permanent Power | 1988-1995 |
| o | Nut Island Headworks, Inter-Island Conveyance System and South System Pumping Station | 1990-1994 |
| o | Primary treatment facilities | 1991-1995 |
| o | Phase 2 - Site Preparation | 1991-1995 |
| o | Secondary treatment facilities | 1995-1999 |
| o | Phase 3 - Site Preparation, including final landscaping and civil work | 1995-2000 |

The construction plan based on the conceptual design information developed for the facilities plan represents an optimum means of achieving the goals set forth by the court-imposed cleanup schedule for Boston Harbor.

### 1.5.5 OPERATION AND MAINTENANCE ORGANIZATION

The new facilities will require a significant expansion in the number of staff, level of staff skills, and systems used to operate and maintain the MWRA's wastewater treatment system. To provide a realistic assessment of the numbers of staff and skill levels required, a suggested organizational format was developed in conjunction with the MWRA Sewerage Division and the Operations Review Committee convened for this facilities plan. The suggested organization consists of a decentralized or section concept with personnel assigned directly to a working section. Four major sections are suggested for the new teatment facilities: operations, maintenance, administration, and laboratory. This type of organizational concept is used at most of the large wastewater treatment facilities in this country. The objectives of the organizational structure include:

- Provide effective management and supervision of the large staff.

- o Guide the staff towards achievement of the Authority's objective of effective pollution control.
- o Direct staff to maintain high productivity.
- o Provide an efficient structure for information flow.
- o Provide support functions to operating staff.
- o Minimize operations and maintenance costs while attaining performance objectives.
- o Establish accountability through all staffing levels.
- o Provide career ladder for employees.

The hierarchy of the suggested structure is shown in Figure 1.5.5-1. Managers of the four organizational sections would report to the plant superintendent. Facilities included under the suggested organizational format include the three remote headworks on the North System, the Nut Island headworks, the new treatment facilities recommended for Deer Island, and the residuals management facities. The total estimated staffing requirement for the operation and maintenance of these facilities is 540 persons. This includes an allowance of 72 persons for operation/maintenance of residuals-related facilities. The actual staffing required for operation of residuals facilities will be determined by the Residuals Management Facilities Plan. This staffing is subdivided among the four sections as follows:

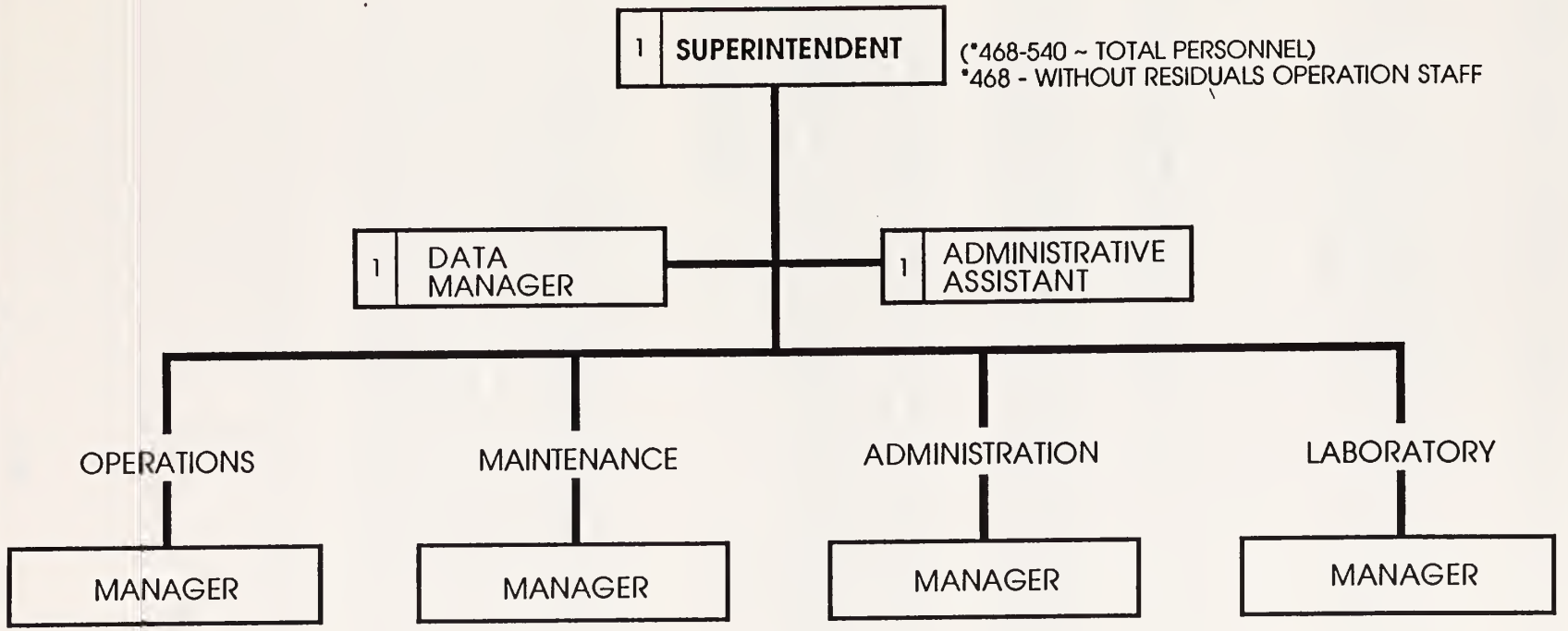
| | |
|---|---|
| Administration | 40 |
| Maintenance | 263 (275 with residuals facilities) |
| Operations | 149 (209 with residuals facilities) |
| Laboratory | 16 |

## 1.5.6 ENVIRONMENTAL CONSIDERATIONS

The environmental assessment of the treatment recommendations considers impacts on groundwater, air quality, land use and visual aspects, noise, terrestrial and aquatic ecology, and historic and archaeological resources on both Deer and Nut Island. Environmental impacts associated with the discharge of the treated secondary effluent through the ocean outfall are addressed in Volume V of this facilities plan.

### Groundwater

Groundwater levels on Deer Island generally vary between elevations 108 and 114 ft. Since most




MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 1.5.5-1**

**DEER ISLAND WASTEWATER COMPLEX**
**ORGANIZATIONAL CHART - MANAGEMENT TEAM**

construction activity at Deer Island and Nut Island will be well above groundwater levels, and no future use of groundwater is proposed at the new facilities, no impacts on this resource are expected.

A secure landfill will be located in the southernmost landform on Deer Island and will provide for the disposal of the grit and screenings presently buried south of the central drumlin. The landfill design will comply with the DWPC criteria for "sludge only" landfills and will use a double liner and leachate collection system to provide permanent protection for the groundwater resource.

Air Quality

The applicable air quality standards for the Commonwealth of Massachusetts are the same as the National Ambient Air Quality Standards (NAAQS).

The air quality impacts of the power and pump stations on Deer Island indicate that the 1995 power generating configuration would improve air quality in the area for all pollutants, compared to existing emissions, with the exception of TSP, which would remain essentially the same.

The proposed treatment system incorporates covering the treatment process units through the aeration basins and air emission controls will be operated such that even under a worst-case scenario, the impacts will be within allowable air quality limitations at all locations which are accessible to the public. At the more easily accessible locations (neighborhood sites adjacent to the facility), the impacts have been determined to be insignificant.

Land Use and Visual Impacts

Deer Island

Construction and operation of the new wastewater treatment facility on Deer Island will change land use on those portions of the island currently used for activities other than wastewater treatment. Upon completion of the construction activities at the turn of the century, virtually the whole island will be dedicated to wastewater treatment. Existing facilities will have been demolished (with the exception of historic structures identified for preservation and reuse), and earth movement will significantly change the profile of the island. Earthen berms will serve to separate the treatment plant and the Town of Winthrop. A large area of open space on the neck of the island and a footpath located along the eastern edge of the island will be open for public access.

Upon completion of the facility and landscaping, the island will appear more natural from most viewing locations than it does at present.

Nut Island

The construction of the new headworks on Nut Island should significantly improve the compatability of land use with abutting neighborhoods as well as provide a new area for passive recreational opportunities. The appearance of the site will be more natural, with landscaping and vegetation replacing the current concrete and asphalt surfaces.

Traffic

Transportation impacts resulting from the construction of the Deer Island Treatment Facilities will be minimal. Although large numbers of workers and quantities of construction materials will be required, half of the workers will be transported by ferry and the remainder will be transported by buses, using satellite facilities. With the exception of contingency trucking, all materials and equipment will be transported to Deer Island by barge.

Transportation impacts at Nut Island are being addressed in the on-island Water Transportation Facilities Planning FEIR.

Noise

Deer Island

Operation Noise. The new wastewater treatment facility on Deer Island will include equipment such as pumps, compressors, motor drives, a gas turbine, and an oxygen generation system, which have the potential to create audible off-site noise. An analysis was performed to identify the significant potential contributors to off-site noise, estimate their sound levels in Point Shirley, and select the appropriate noise mitigation required to minimize operations noise impacts.

To evaluate noise impacts from the facility, ambient noise levels were measured to serve as evaluation criteria. The levels found were 39 dBA nighttime and 45 dBA daytime. The noise evaluations have indicated that no noticeable increases above these evaluation criteria will be experienced during facility operation.

A considerable amount of the equipment will require noise attenuation. However, with the implementation of noise mitigation, the total sound level contribution of the facility at the nearest neighbor during nighttime hours is expected to be approximately 36 dBA, 3 dBA lower than the minimum ambient sound levels measured in 1986. Under the most favorable noise propagating conditions, a less than 2 dBA increase in existing ambient sound levels will occur. This change in ambient sound levels will not be noticeable.

Construction Noise. The construction of the facility will continue over a period of approximately twelve years, 1988 to 1999. During that time numerous buildings, treatment facilities and earthen landforms will be constructed. and the existing plant and prison will be demolished. The greatest potential for noise impact at Point Shirley will occur during the early stages of construction with the movement and placement of the earthen landform at the

northern end of Deer Island. Once constructed, this landform will serve to buffer the remainder of the construction noise.

The criteria of 39 dBA, nighttime, and 45 dBA, daytime, were also used to evaluate noise impacts from facility construction. Various mitigation strategies were employed to implement a noise control objective which would limit intrusive daytime construction noise to no more than 10 dBA over those ambient levels.

The most significant noise mitigating measure which will be utilized during construction is the placement of new landforms. The northern landform has been determined to be an effective noise barrier during construction, reducing noise perceived at Point Shirely by about 10 dBA eighty-three percent of the daytime. Maximum construction noise at Point Shirley will be approximately 50 to 54 dBA during upwind and cross-wind conditions, when the noise barrier is most effective. Approximately 17 percent of the time down-wind conditions limit the effectiveness of the noise barrier. Noise levels range between the low 50s to a maximum of 65 dBA under these worst-case conditions. Analysis of ambient noise monitoring data from Point Shirley has indicated that these projected, worst case impact noise levels are characteristic of the area and occur 97 percent of the daytime for about six minutes each hour. The projected construction noise levels are similar in magnitude to the existing daytime median or $L_{50}$ levels, which range from 47 dBA to 63 dBA.

Nut Island

Operation Noise. The new grit and screening facility at Nut Island will be completely enclosed, with expected sound levels of less than 25 dBA at the nearest residential area. Since the daytime and nightime minimum ambient sound levels have been reported at about 50 dBA and estimated at 30 to 35 dBA, respectively, operation noise at the screenings facility will not be audible at the nearest residential area.

Construction Noise. The primary construction activities on Nut Island consist of the demolition of the existing facility, site preparation, and construction of the new building. The construction sound level is expected to be 63 dBA from 1992 to mid-1995, dropping to 60 dBA for the remaining year of construction.

Terrestrial and Aquatic Ecology

Sources of potential impacts on fauna and flora associated with the construction effort include: habitat removal and the subsequent displacement of fauna from cleared areas; the generation of fugitive dust; increased potential for erosion of cleared surfaces; construction generated noise; and the movement of construction personnel, equipment and materials on-site.

Land clearing is expected to have an adverse impact on the habitat of local wildlife species. However, none of the faunal species are endangered, threatened, or otherwise unique. The post-construction repopulation of the species on Deer Island is expected; thus the loss of these individuals does not constitute an impact of consequence.

The existing flora, primarily grass, is fairly resistant to impacts from fugitive dust. Dust control will be implemented through the use of water spray trucks to dampen exposed surfaces. No impact of dust on vegetation in adjacent communities is expected.

Erosion will be controlled through temporary stabilization of graded areas with seeding, tacking or mulching until permanent cover is established. The construction mitigation program will ensure that runoff from exposed surfaces will drain to settling basins, holding ponds, hay bale barriers and/or silt fences prior to discharge to the harbor.

Since the areas surrounding the construction zones presently do not support an appreciable number of wildlife species, no long-term deleterious impact from construction-related noise and movement of personnel, equipment and supplies is anticipated.

Few if any negative impacts on the terrestrial and aquatic ecology are anticipated from the construction and operation of the headworks on Nut Island.

Historic and Archaeological Resources

No historical or archaeological resources have been identified on Nut Island.

Historical and archaeological resources on Deer Island consist of the following:

- Hill Prison
- Prison Superintendent's House
- Steam Pumping Station
- Farmhouse
- New Resthaven Cemetery

Consideration was given to potential preservation and reuse of these resources, compatible with the treatment facility site planning needs; impacts of site development on these resources; and proposed measures which would mitigate impacts on these resources.

The land requirements for the new secondary treatment facility use virtually all of the land on Deer Island and thus reduce the flexibility for planning reuse of historic structures.

Site planning evaluations have recommended that the Hill Prison and the Farmhouse be documented for the Historic American Building Survey and subsequently demolished. The Superintendent's House will be moved to a higher elevation and reused as a security center for the new treatment plant. The Steam Pumping Station, situated near the water where the proposed piers will be constructed, will be renovated and expanded for use as the administrative and laboratory functions. The Resthaven Cemetery will be left intact: the addition of 30 to 40 ft of fill material to the surface of the Cemetery will provide a mitigating noise and visual barrier, and will act as an appropriate preservation for the Cemetery.

## 1.5.7 INSTITUTIONAL CONSIDERATIONS

### Training and Staff Development

The creation of a highly skilled treatment plant staff and the proper placement of trained staff throughout the entire organizational structure are the key elements to the successul operation of the proposed treatment facilities.

Staff must be procured in sufficient time for training prior to the scheduled startup of the treatment facilities. Training of the staff is of paramount importance in the effort to provide optimum operational efficiency in terms of plant effluent quality and operating costs, and to protect the enormous capital investment in pollution control facilities.

The new facilities will require that licensed operators be in charge of all shifts. To satisfy this requirement, the plant superintendent and the five shift supervisors must have Massachusetts Grade 7 certifications. In addition, the qualifications for various supervisory and staff positions should include an appropriate certification requirement. The completed secondary treatment facilities will require about 540 employees. This represents an increase of about 300 persons over the present level of employment. Approximately 80 of the estimated 540 staff positions could have certification requirements written into in the position qualifications.

The large number of licensed operators and certified staff included in the suggested Deer Island organizational scheme exceeds the existing supply in Massachusetts. The required Grade 7 operators for superintendent and shift supervisor positions can be filled by placement of existing staff and procurement of experienced, licensed personnel. However, in order to succeed in acquiring the total certified staffing, training programs will have to be implemented. Existing training programs in New England are not capable of providing the required numbers of licensed and certified staff. The recommended approach to satisfying staff training and certification requirements for the new facilities is through an on-site training program at Deer Island. All of the necessary training, with the possible exception of laboratory training, can be performed on-site. The training program should be developed, prepared, and delivered based on the equipment and facilities being placed into operation at Deer Island and the remote headworks.

The intricacies of the new MWRA treatment facilities and four remote headworks, coupled with additional unique conditions such as the location of the Deer Island facilities and concerns associated with transportation of workers to and from the site, the regional competition for skilled labor, and the local cost of living, compound the difficulties associated with staff procurement and development. These issues must be addressed by:

- Development of a procurement strategy that addresses the number of new hires required to staff the Deer Island facilities.

- Establishment of pay scales and benefit packages that will attract and retain qualified and skilled personnel.

- Establishment of training and certification programs for the various staff levels.

- Establishment of career ladders illustrating the advancement opportunities within the organization.

- Identification of alternative means of commuting to the Deer Island site.

These issues must be addressed and resolved so that operations and maintenance staff will be in place for the startup of primary treatment facilities in 1995 and for the startup of the secondary facilities in 1999. A suggested procedure includes:

1. Adoption of an organizational structure for management/operation of the new facilities.

2. Preparation of complete position descriptions, including duties and qualifications, for each position in the organizational structure.

3. Adoption of salary schedules and benefit packages per position and grade.

4. Determination of staffing needs for startup and operation of the phased facilities.

5. Procurement and placement of staff. (This includes a review of qualifications and placement of the existing staff into the new organizational structure, and the hiring of new personnel.)

6. Development of programs to train the staff to operate the new facilities.

7. Training of personnel, phased as required to meet the needs of the new facilities.

# Section 2

# 2.0 INTRODUCTION

## 2.1 PROJECT NEED

Since the time of the Revolutionary War, Boston Harbor has been considered a national landmark. The largest seaport in New England, it supports a variety of marine activities including shipping, fishing, boating and recreation. It encompasses an area of 47 square miles bordered by residences, commercial buildings, restaurants, marinas, beaches, industries and shellfishing flats. But since the settlement of Boston's shore areas, and most particularly since the City of Boston took possession of Deer Island for "sanitary purposes" in 1847, the Harbor has been the receiving water for all of the domestic, commercial and industrial wastewater and stormwater from the Boston metropolitan area.

Today, nearly 5,000 miles of sewers, conduits and pipes collect sewage from 1.9 million people and 43 metropolitan cities and towns and transport it to the area's two sewage treatment plants at Nut Island and Deer Island for treatment prior to discharge to Boston Harbor. Both of the plants are designed to provide primary treatment. Each plant provides disinfection of the primary effluent prior to discharge to the Harbor to reduce the levels of pathogenic bacteria. The disinfected effluent from Deer Island is discharged through two diffuser equipped outfalls into President Roads approximately 1,500-2,000 feet from Deer Island. Two additional relief outfalls are located 500-750 feet from Deer Island.

The disinfected effluent from Nut Island is discharged north through two main outfalls into Nantasket Roads approximately 4,500-5,000 feet from Nut Island. During periods of high flows and/or extremely high tides a third outfall extending about 1,500 feet north into West Gut side of Hingham Bay may be used. In addition, an emergency outfall extends 500 feet into the Hingham Bay side of West Gut.

The sludges removed from both plants are anaerobically digested and discharged into President Roads on the outgoing tide. Figure 2.1-1 illustrates the location of each of the treatment facilities and discharge locations. The combined discharge of primary effluent and sludge to the relatively shallow waters of Boston Harbor imposes a significant burden on the marine ecology in the waters surrounding the discharge. The discharge of floatable materials results in a significant deterioration in the aesthetic qualities of this vital resource. Because these discharges are but a few of the total discharges to Boston Harbor, and because scientific research to delineate the impacts of each discharge on the Harbor has been limited to date, the precise impacts of the primary effluent and sludge are difficult to quantify. However, these discharges are unquestionably very sizable and the materials being discharged are ecologically significant. Thus, every reasonable effort should be made to reduce these discharges.

The Deer Island treatment facilities were constructed in 1968, and the Nut Island treatment facilities in 1952. Both facilities have exceeded their useful lives and the levels of treatment provided are often less than optimal because of the unavailability of replacement equipment. Nut Island has recently undergone a rehabilitation of most of its major components. A similar rehabilitation is now underway for Deer Island. Rehabilitation of the existing

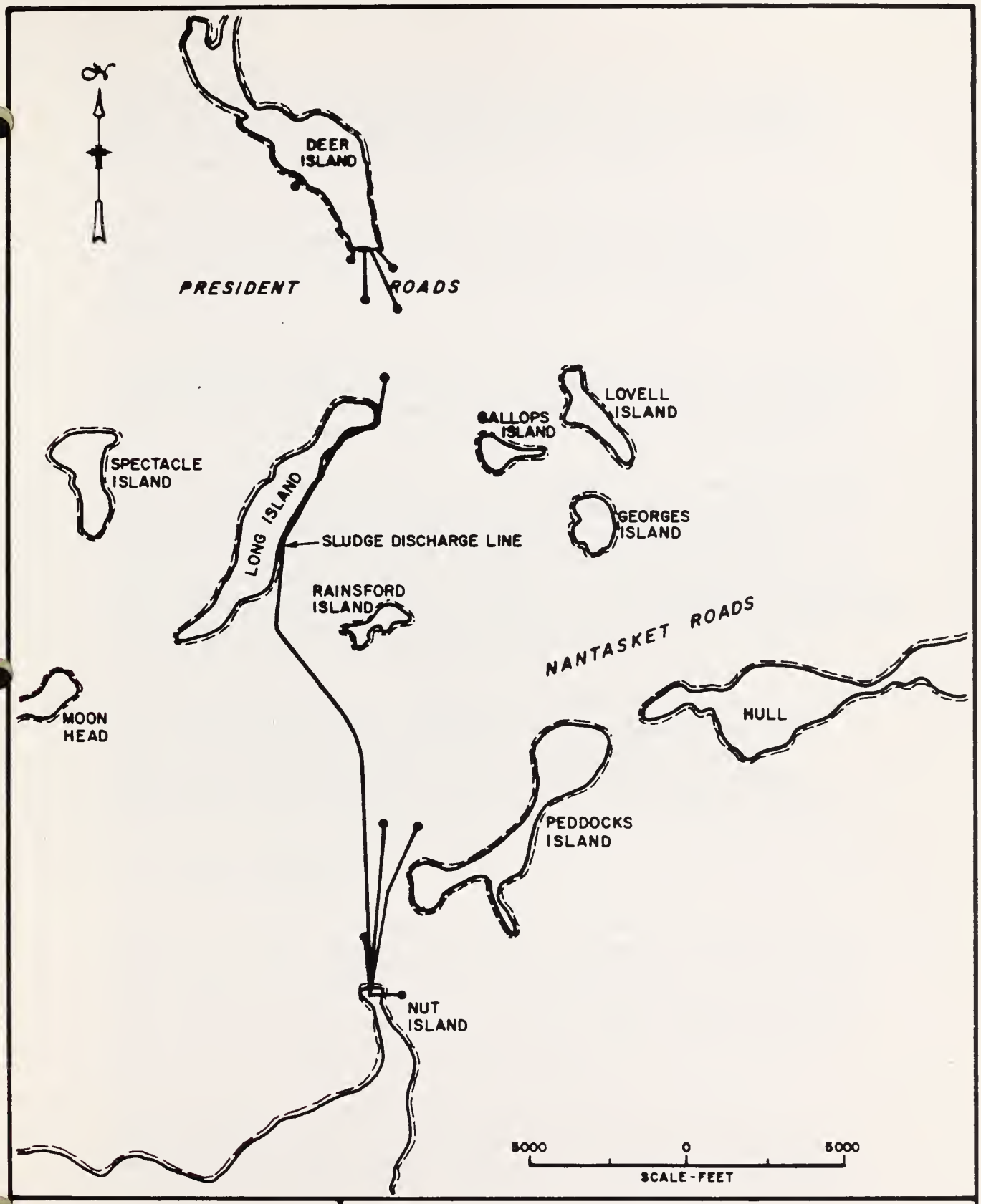



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**FIGURE 2.1-1**
**DEER ISLAND AND NUT ISLAND EFFLUENT AND SLUDGE DISCHARGE LOCATIONS**

treatment facilities will optimize the levels of removal that these facilities can consistently provide. However, even the rehabilitated facilities cannot provide the levels of treatment desired. The design criteria and installed equipment of the existing primary facilities do not represent state-of-the art technology; therefore, they require replacement.

The 1972 Federal Clean Water Act requires that all municipal sewage treatment systems incorporate secondary treatment. Secondary treatment is more complex than the primary treatment that the flows at Nut Island and Deer Island currently receive, removing significantly higher levels of both organic materials and solids from wastewater (80 to 90 percent).

Like the Federal Water Pollution Control Act, the Massachusetts Clean Water Act requires promulgation of water quality standards for waters within the Commonwealth. The Massachusetts Division of Water Pollution Control has established these standards to satisfy the requirements of both acts. Thus, both Federal and State statutes require increased levels of treatment.

In 1982, the City of Quincy filed a suit against the Metropolitan District Commission (MWRA's predecessor agency) charging violations of laws prohibiting discharges into coastal waters and tidal waters, and violations of the common law of nuisance. As the suit progressed, the Massachusetts Water Resources Authority was created by the Massachusetts legislature. Almost simultaneously with MWRA's creation, the U.S. Environmental Protection Agency filed suit against MWRA alleging violations of the Clean Water Act. The Federal District Court found MWRA to be in violation and ordered the Authority to plan and construct new treatment facilities in accordance with an aggressive schedule (see Section 3.4.)

The need for upgraded and expanded treatment facilities to serve the Boston metropolitan area is clear: current discharges place a significant burden on one of the area's vital natural resources; the existing treatment facilities have long exceeded their useful lives; the existing treatment facilities do not reflect state-of-the-art technology and design; Federal and State statutes require enhanced levels of treatment; and the Federal Court has intervened and ordered an upgrading of the treatment facilities.

## 2.2 PLANNING APPROACH

This facilities planning study provides the foundation for the Massachusetts Water Resources Authority's program for the construction and operation of new primary and secondary wastewater treatment facilities at Deer Island. This planning has been approached with the understanding that the facilities planning effort must secure and sustain the acceptance and support of the diverse community, government and business interests that it affects. Therefore, the planning process was based not on technical strength alone, but also on the continual reconciliation of political, legal, environmental, economic and community interests.

A critical component of the facilities planning for secondary treatment facilities has been completed: the siting of the new treatment facilities. The decision-making process and the mitigation commitments made during that siting process are considered to be firm guidance for

the planning to be undertaken in this project. (See Section 3.2 for a description of the siting decision.)

The successful treatment of wastewaters from the Boston metropolitan area requires not only that enhanced treatment facilities be provided, but also that reliable, environmentally sound facilities be provided to manage the disposal of the residuals that are the direct by-products of wastewater treatment. The residuals management facilities plan is being conducted as a separate but concurrent study. The facilities needed and the sites being considered for residuals management are quite different from those needed for secondary treatment. However, the schedule for completion of the residuals management facilities plan is similar to the schedule for this plan. In addition, the approach and work plans for both of these planning studies recognize the synergistic relationship of these two plans. Thus, this planning study must be read with full cognizance of the residuals management facilities planning.

The facilities needed to provide secondary treatment include new primary and secondary treatment facilities located on Deer Island; a new conduit to convey the wastewaters from the existing Nut Island plant to Deer Island (inter-island conveyance facilities); and a new outfall to discharge the treated effluent into the ocean. In addition, a fourth component has been identified for the project: early site preparation. Early site preparation is defined as any construction activity that can start at an early date, i.e., before the completion of the on-island piers facilities needed to move the construction materials, equipment and personnel to the Deer Island site. The facilities planning for secondary treatment has thus been broken into four, stand-alone studies:

Treatment Plant, Volume III
Inter-Island Conveyance System, Volume IV
Effluent Outfall, Volume V
Early Site Preparation, Volume VI

To expedite the planning and review process, the facilities planning for secondary treatment has received a designation as a "major and complicated" project under the Massachusetts Environmental Policy Act regulations. The "major and complicated" project designation permits the environmental reviews to be concurrent with, and an integral part of, the facilities planning process. Thus, the documents being prepared to summarize the facilities planning are the same documents which will be used for environmental reviews.

The scope and sequencing of these facilities planning and environmental review activities are described in the following section.

## 2.3 SCOPE OF WORK

The purpose of the Secondary Treatment Facilities Plan is to evaluate the facilities needed to provide primary and secondary treatment, at a single facility to be located on Deer Island, of the wastewater conveyed through MWRA's North and South Systems. It will evaluate the

facilities needed to convey the South System flows from the existing Nut Island plant to Deer Island, as well as the outfall facilities needed to convey the effluent flows from Deer Island to a disposal point in marine waters. It will also identify and evaluate the construction activities which can occur as part of the Early Site Preparation effort prior to completion of the on-island piers and in preparation for the construction of the primary facilities.

The scope of work for the facilities plan is summarized below.

Project Management provides the overall project management required to ensure that the facilities plan is completed on time, within budget and with high standards of quality.

Data Collection inventories current and planned upgraded equipment and processes, assembles data regarding process equipment, mechanical, structural and hydraulic conditions, operating and maintenance characteristics, and expected useful life. Data Collection also will project flows and loadings, define the planning area, and provide a basis for evaluating further growth. This task will develop performance/removal criteria that will be used to balance the level of treatment required and the outfall location.

Facilities Engineering will characterize the wastewater to be treated, develop initial alternative planning and architectural concepts for Deer Island and ancillary facilities at Nut Island; complete site planning requirements; evaluate the adequacy of existing preliminary treatment facilities and evaluate unit processes for screening and grit removal; evaluate unit processes for primary treatment and residuals collection; evaluate unit processes for secondary treatment and residual collection; evaluate unit processes for disinfection; identify and evaluate the ability to control air emissions; establish alternative noise control methods and prepare a noise control plan for treatment plant operations and construction activities; determine the need for a pilot plant; evaluate the route and construction technology for locating and constructing the inter-island conveyance system and new effluent outfall; select an area for the outfall discharge which will meet water quality standards; characterize the soil and rock conditions under the proposed facility and related wastewater conveyance systems; identify and evaluate treatment processes; evaluate the reliability and flexibility of each of the treatment alternatives; estimate capital costs for the selected facilities and equipment; identify and estimate utility needs; identify operator needs and develop a preliminary operations plan; outline the requirements to operate the existing plants during construction; and provide pre-construction planning.

Institutional tasks include development of an annual cash flow projection required for the construction of the facilities; identification of the financial impacts of the recommended plan on MWRA's customers; identification of proposed changes or additional laws, regulations, legislative restrictions and agreements that may affect the implementation of the facilities plan; description of potential permit and regulatory agency approval requirements and preparation of a preliminary permitting plan; and implementation of a full-scale public participation program.

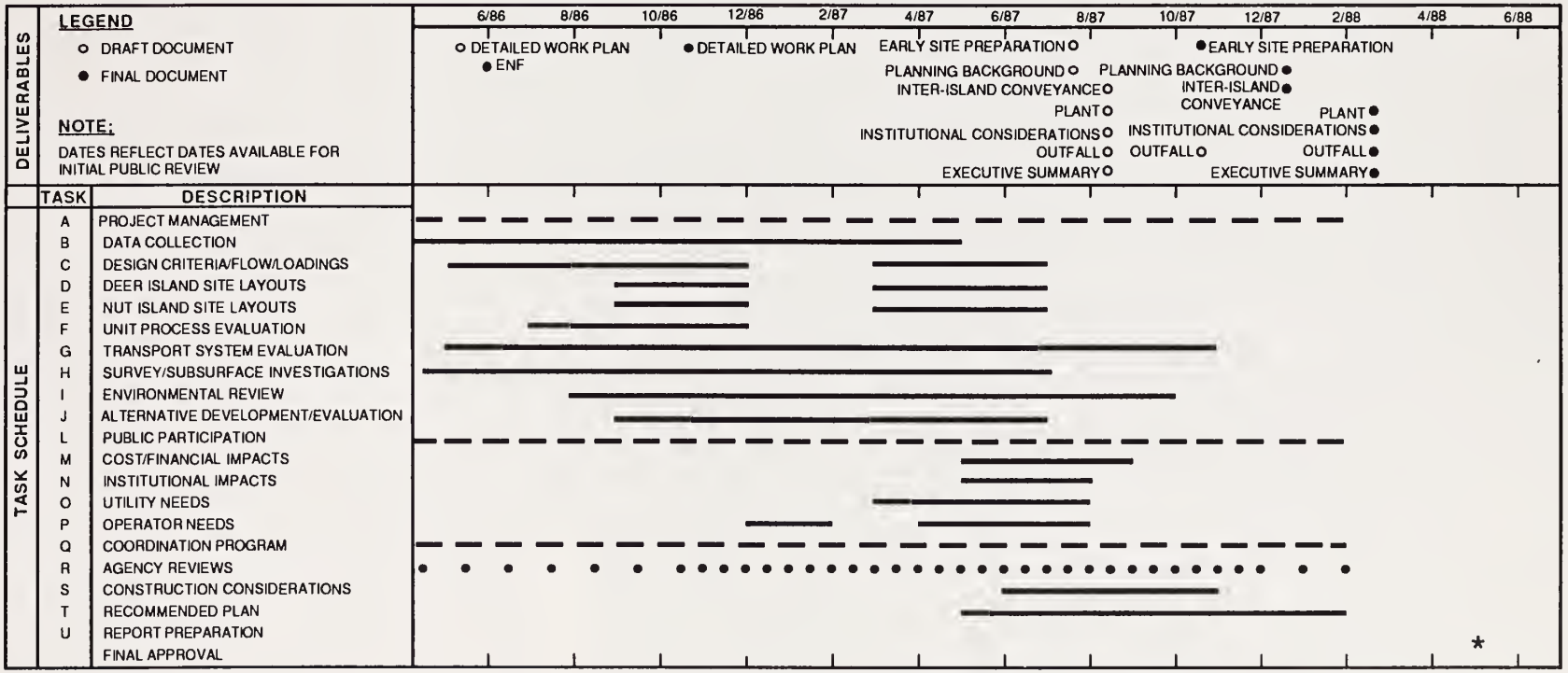
Recommended Plan is the preparation of the Secondary Treatment Facilities Plan and development of an implementation schedule/plan for each design and construction phase, as well as the

coordination of, and response to, reviews by regulatory agencies.

A more detailed outline of each work task will be found in Appendix A. Figure 2.3-1 illustrates the general flow of the planning activities.

## SCHEDULE OF MAJOR DELIVERABLES

| VOLUME | NAME | DRAFT REPORT | FINAL REPORT |
|---|---|---|---|
| I | EXECUTIVE SUMMARY | 9/87 | 2/88 |
| II | PLANNING BACKGROUND | 6/87 | 12/87 |
| III | WASTEWATER TREATMENT PLANT | 9/87 | 2/88 |
| IV | INTER-ISLAND CONVEYANCE SYSTEM | 8/87 | 12/87 |
| V | EFFLUENT OUTFALL | 11/87 | 3/88 |
| VI | EARLY SITE PREPARATION | 7/87 | 10/87 |
| VII | INSTITUTIONAL CONSIDERATIONS | 9/87 | 2/88 |




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

# FIGURE 2.3-1
# SECONDARY TREATMENT FACILITIES PROJECT PLANNING SCHEDULE

# Section 3

# 3.0 PROJECT BACKGROUND

## 3.1 PREVIOUS STUDIES

Since 1900, there has been concern over water pollution problems in Boston Harbor. The State legislature initiated six investigations into the condition of the Harbor between 1900 and 1939. The last of these investigations resulted in the construction of the present Deer Island Treatment Plant which was completed in 1968.

But even as the Deer Island Plant was completed, the Federal Water Pollution Control Administration released a report on the impact of pollution on the Harbor's waters citing recreational, economic and biological impairment. The report generated increased interest in addressing pollution problems and at the first Enforcement Conference on Boston Harbor, state and federal officials agreed on the formation of a technical study group to explore measures for pollution abatement. The recommendations and agreements which grew out of these conferences, in conjunction with the mandates of the Federal Water Pollution Control Act and the Massachusetts Clean Water Act, have formed the framework for attacking pollution in Boston Harbor.

The process of identifying long-term wastewater treatment needs and solutions for the greater Boston Metropolitan area began in 1973 when the Metropolitan District Commission (MDC) began work on wastewater engineering and management planning for Boston Harbor. (Table 3.1-1 provides a list of planning reports for wastewater treatment in Boston Harbor.) The Eastern Massachusetts Metropolitan Area Wastewater Management and Engineering Study (EMMA) was conducted to ascertain what repair, replacement, extension, and expansion of facilities were required to provide adequate sewage treatment for the next fifty years.

In the fall of 1976, following publication of the EMMA Study, EPA's regional office requested that an Environmental Impact Statement (EIS) be prepared before any facilities planning. When the draft EIS was completed in 1978, it resolved the controversy regarding satellite facilities and proposed the consolidation of all planned treatment facilities on Deer Island.

A few months prior to the publication of the EIS, the MDC had responded to the 1977 amendments to the Clean Water Act which provided for a waiver of secondary treatment. If a waiver were granted, much of the construction contemplated in the EMMA Study would be deferred, at least until expiration of the modified permit, and perhaps indefinitely if the permit were renewed. Nevertheless, because regulations pertaining to the waiver process required that facilities plans to provide secondary treatment be prepared concurrently with the waiver process, the MDC, following release of the draft EIS, began preparation of a facilities plan.

Starting in 1983, the EPA and the Commonwealth jointly prepared the Supplemental Environmental Impact Statement/Environmental Impact Report (SEIS/DEIR) on the Site Options Study. The purpose of this document, which augmented the EIS evaluations done on the EMMA Study, was to review the environmental impacts of the Site Options Study alternatives, as well as other alternatives within the context of both the National and Massachusetts Environmental Policy Acts. The SEIS/DEIR started with twenty alternatives and selected seven treatment plant siting

alternatives for final review. The MWRA later reinstated one alternative for final review. Four alternatives involved secondary treatment and four involved primary treatment. The alternatives considered included locating all treatment facilities at Deer Island, all treatment facilities at Long Island, or combinations of plant locations that used Deer, Long, and Nut Islands together in various configurations.

Also in 1983, almost five years after MDC filed a preliminary application for waiver of secondary treatment, the application was tentatively denied by EPA. Because of intervening regulatory developments, MDC was entitled to file an amended application. Shortly thereafter, MDC notified EPA of its intent to do so, and a scope of study was agreed upon, including water sampling to be performed in the summer of 1984. Final submissions were made by MDC in October, 1984.

Although the cost implications of secondary treatment and the ultimate rate-payer impacts promoted pursuit of the waiver application over several years, the waiver application exacerbated two major problems in planning the cleanup of Boston Harbor. First, as long as the "level" of treatment (secondary vs primary) was uncertain, the nature and size of new treatment facilities were impossible to fix for planning purposes. Second, planning for sludge management was frustrated because of the disparity in both the tonnage and character of sludge from secondary treatment as opposed to primary treatment. On March 29, 1985, EPA rejected MDC's amended Section 301 (h) waiver application.

The Massachusetts Water Resources Authority assumed control of the MDC sewerage system on July 1, 1985. The MWRA made the decision to proceed as fast as possible with the secondary treatment program for Boston Harbor, notifying EPA that they would choose a preferred alternative for focused analysis by early July, 1985.

Table 3.1-1 lists planning projects undertaken for Boston Harbor wastewater treatment since the 1976 EMMA study.

## 3.2 SITING DECISION

The MWRA determined that the seriousness of the siting decision to be made and the newness of the MWRA as a participant in the decision process merited a thorough review of the material presented in the SDEIS/DEIR and comments made pursuant to that document, as well as a consideration of all additional information being developed in response to the issues raised by those comments.

The MWRA began its site selection process by reviewing the six criteria established in the SDEIS/DEIR (i.e., cost, effects on natural and cultural resources, effects on neighbors, harbor enhancement, implementability, and reliability). The MWRA voted to adopt these six criteria, but determined that two additional criteria should be adopted as well: equitable distribution of regional responsibility; and mitigation measures. The first of the new criteria, equitable

## TABLE 3.1-1

## SUMMARY OF PLANNING REPORTS FOR WASTEWATER TREATMENT IN BOSTON HARBOR

| | |
|---|---|
| 1976, March | Eastern Massachusetts Metropolitan Area Wastewater Engineering and Management Plan of Boston Harbor, Metcalf & Eddy, Inc. |
| 1976 | Non-structural Controls for Combined Sewer Overflows, Environmental Research and Technology, Inc. |
| 1976, May | Joint Task Force Report on Major Manned MDC Facilities Located in the Greater Boston Area, EPA Region 1 |
| 1976, July | Wastewater Management Planning: Boston Metropolitan Area Phase I Study, Urban Systems Research and Engineering, Inc. |
| 1976, July | Phase I Engineering Report Boston Case Study, Kennedy Engineers, Inc. |
| 1976, August | Phase I Final Report on Greater Boston Water Quality Issues in Planning for Pollution Control, Verlex Corp. |
| 1976, November | Boston Metropolitan Area Waste Treatment Feasibility Study, Stone & Webster Engineering Corp. |
| 1979, January | Wastewater Treatment Facilities Planning in the Boston Metropolitan Area - A Case Study, Kennedy Engineers, Inc. |
| 1979, September | Application for Modification of Secondary Treatment Requirements for Discharge into Marine Waters of Boston Harbor and Massachusetts Bay for its Deer Island and Nut Island Wastewater Treatment Plants, MDC |
| 1980, December | MDC Headworks Grit and Screenings Removal Systems - Preliminary Report, Whitman and Howard, Inc. |
| 1982, June | The Commonwealth of Massachusetts Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study, Volumes I and II, Metcalf & Eddy, Inc. |
| 1982 | Nut Island Wastewater Treatment Plant Immediate Upgrading, Metcalf & Eddy, Inc |
| 1984 | Deer Island Facilities Plan, Havens & Emerson/Parsons Brinkerhoff |

**TABLE 3.1-1**
**(continued)**

**SUMMARY OF PLANNING REPORTS FOR WASTEWATER TREATMENT IN BOSTON HARBOR**

| | |
|---|---|
| 1984 | Supplemental Draft Environmental Impact Statement and Draft Environmental Impact Report, EPA |
| 1984 | Application for a Waiver of Secondary Treatment for the Nut Island and Deer Island Treatment Plants, Metcalf & Eddy, Inc. |
| 1985, November | Final Environmental Impact Report on Siting of Wastewater Treatment Facilities for Boston Harbor, Camp Dresser & McKee, Inc. |
| 1985, December | Final Environmental Impact Statement on Siting of Wastewater Treatment Facilities for Boston Harbor, EPA |

distribution of regional responsibility, was viewed as subsuming the "fairness" issue which had been the subject of substantial commentary on the SDEIS/DEIR. The second new criterion, mitigation measures, was adopted to ensure consideration of both environmental and non-environmental mitigation and to permit the MWRA to fully respond to mitigation concerns during its siting deliberations.

The MWRA next reviewed the site options to be considered. It voted to examine the seven site alternatives proposed at the conclusion of the SDEIS/DEIR (all secondary Deer Island, split secondary Deer Island and Nut Island, all secondary Long Island, split secondary Deer Island and Long Island, all primary Deer Island, split primary Deer Island and Nut Island, split primary Deer Island and Long Island) and, in response to the Secretary's Certificate of Adequacy on the SDEIS/DEIR, also voted to reinstate for evaluation one site option that had been dropped from consideration at the close of the SDEIS/DEIR (all primary Long Island).

The MWRA then proceeded to an evaluation of each site alternative in the context of the criteria selected. A number of consultants were engaged to assist in the collection, evaluation, and presentation of pertinent materials to the Board members at their publicly held meetings. Oral and visual presentations on each of the eight criteria were given, followed by questions and discussions which refined the issues to be addressed and identified additional information to be obtained. Second presentations and discussions were held on seven of the criteria, and a third round of review and debate occurred on the criterion of cost. As a consequence of these deliberations, further presentations and discussions were held on several sub-topics that were of particular interest or thought to require additional attention.

In addition to its own consultants' presentations, the MWRA heard and discussed presentations by the Regional Administrator of EPA, by representatives of the Executive Office of Environmental Affairs and the Department of Environmental Quality Engineering, and by the technical and legal representatives of the Town of Winthrop and the City of Quincy. In all, the MWRA listened to and discussed at some length, 23 separate presentations on 13 different topics applicable to the preferred alternative siting decision.

A summary of all the siting presentations given and the Board's discussions was provided to the Board members for further review and analysis prior to the vote on the tentative preferred alternative site selection. Copies of letters from officials and the public concerning the siting decision were either provided to Board members during the ongoing deliberations or were included in the siting summary notebook. The Board members also visited the sites being considered.

The following sub-sections contain summaries of the MWRA's deliberations concerning each criterion as it applied to the site selection to be made. Throughout the process of selecting the tentative preferred alternative site, the MWRA evaluated and compared the information received in light of the criteria adopted. It observed interrelationships among the criteria and discussed the value to be accorded to the criteria in the context of various site alternatives. The last sub-section summarizes the way in which the criteria weighed one against the other with respect to the sites considered.

### 3.2.1 EFFECT ON NEIGHBORS

The purpose of this criterion was to address treatment facility impacts on the neighbors of the treatment plant. Factors evaluated by the MWRA were traffic, noise, odor, visual effects, property values, and health and safety issues. An exploration of the numbers of persons potentially impacted by the proposed primary, secondary and split treatment plant site options was conducted. Distinctions were made between those who might be voluntarily exposed to the negative impacts and those who resided nearby and had no choice with respect to being impacted, with greater value being accorded to the latter. Consideration was also given to the potential impact of the treatment plant on those working, living or staying at either the hospital on Long Island or the prison on Deer Island. Weight was attached to the fact that persons in the institutions would be closer to the source of impacts for longer continuous periods and would be exposed to a higher degree of impact at any given time. Concern about the effects on these populations served in part to motivate the MWRA to analyze in more detail the "footprints" that could be accommodated on Long Island and on Deer Island and the need for and feasibility of mitigative design concepts, buffers, and/or the relocation of the respective institutions. Also considered was the exposure to impacts over a longer period of time as would be the case for most of the residential neighbors.

Traffic

Traffic access roads were reviewed for capacity and for anticipated peak and average use with and without the utilization of barging and busing. The MWRA learned that the greatest numbers of persons would be affected along the Winthrop access routes, but that a substantial number of persons would be affected along the East Squantum access routes as well. The fewest persons would be affected if the Quincy Shore Drive route to Long Island were available, but there were questions of implementability and structural feasibility that would have to be resolved in order to use that route. The degree of negative impact on the various roads was considered to be roughly the same for the various site alternatives.

A great deal of consideration was given to barging, with the recognition that it was required in order to sufficiently mitigate the traffic impacts that would be caused during construction. Implementability issues with regard to barging -- such as Coast Guard regulations and the construction of piers -- were explored, as were the costs of barging. A determination was made that the same requirements for barging applied to whichever site alternative was selected, and therefore the concerns surrounding barging as a mitigation measure for the alleviation of traffic impacts on neighbors were found to be not site-determinative.

Also reviewed were the potential mitigation measures of ferrying workers to decrease traffic, and rehabilitating or replacing access bridges to accommodate heavy trucking. Implementing each of these measures appeared to pose a relatively similar degree of difficulty between sites and was not found to be an absolute deterrent. The cost of bridge repair or construction did differ between sites and was explored in greater detail by the MWRA in its concern for the issue of traffic impacts and the need to alleviate them. It was determined that it would be most costly to repair, replace or construct new bridges for access to Long Island. Assuming a heavy reliance upon barging and taking into account the above factors, the MWRA

concluded that the traffic impacts were significant but manageable with respect to all sites, and that this was not a site-determinative factor.

Noise

The information on noise contained in the SDEIS/DEIR was reviewed, and the concerns of the Town of Winthrop with respect to the adequacy of that information and the possible site-determinative nature of construction noise impacts were explored. Berms and temporary noise barriers were also discussed. The MWRA received a detailed letter from, and heard a presentation by, Winthrop's technical consultant. It further pursued additional noise information through the technical advisory group meetings and shared the ongoing work done by EPA's technical consultant. An update of this work was presented to MWRA by EPA shortly before MWRA's siting decision. The information on noise gathered and presented by EPA and adopted by MWRA for its tentative preferred alternative site selection indicated that although noise levels at Deer Island would result in greater impact to neighbors, particularly the close neighbors at the House of Correction, the level of construction noise at either site was at acceptable levels or could be sufficiently mitigated so that it was not a site-determinative issue.

Odor

The impact of odors, taking into consideration source, distance, population density, and potential for occurrence, was also evaluated. In addition to evaluating the effect of odors on nearby residences and the existing institutions, the MWRA considered the effect of odors on potential recreational users. It was determined that there might be intermittent effects on neighbors at either site with a potentially substantial effect on recreators at Long Island Head, given the seasonal wind patterns and projected siting plans.

The use of covered tanks to mitigate odors was explored. The MWRA balanced the mitigating effect of covered tanks against the operation and management difficulties that had been experienced at other plants utilizing covers and also considered the additional cost required to employ covered tanks.

After reviewing odors and their potential impact on any of the sites considered, the MWRA determined that odor control was a paramount concern in the design of the treatment plant and that stringent odor controls would be utilized no matter where the treatment plant was located. Having decided this, and having reviewed the odor impact information, the MWRA concluded that odor and its control posed somewhat different problems at each island but balanced out sufficiently so as not to be a site-determinative issue between Long Island and Deer Island.

Odor impacts were found to have some significance, however, in the choice between all secondary options that retained the existing institutions and those secondary options featuring removal of the hospital or House of Correction. The options featuring retention of the existing institutions were considered less desirable because the ability to design the treatment plant with odor sources farther away from residential or recreational uses was substantially reduced at the more constrained sites. The retention of the institutions also increased the number of

persons impacted and degree of severity of impact with respect to the persons living, working or staying in the institutions.

Visual Effects

It was determined that a treatment plant on either island would have a negative impact on persons in the existing institutions due to proximity. With respect to residential neighbors, it was determined that if the institutions remained, there would be a greater negative impact from a treatment plant on Deer Island. If the House of Correction were removed, however, modifying landforms and landscaping could be used to screen the treatment plant from most residences.

Property Values

The effect on property values of the construction and operation of the treatment plant was addressed. Comparisons of affected communities with respect to fair market value, past appreciation, turnover rates and anticipated changes due to treatment plant construction and operation were reviewed. It was generally concluded that, no matter which site option was selected, property values probably would not decline during successful plant operation. However, there was discussion that there may be a decline of property values for communities near the treatment plant during construction but that these values would likely rebound fully after completion of construction. Also discussed was a projected possibility that property values around Deer Island might not fully rebound after construction. However, it was also deemed possible that the substitution of a carefully constructed and well-run treatment plant on Deer Island might raise values in the neighboring communities higher than they would be with the continuation of the existing plant operation. On the whole, property value impacts were determined not to be site-determinative, but a matter to be addressed through mitigation once a site was selected.

Health and Safety

Health and safety concerns of the community -- such as traffic impacts on schools and the elderly, chlorine delivery, air quality reduction from traffic or the facility operation -- were examined and not found to be site-determinative factors.

Summary of Effects on Neighbors

Most of the effects considered within each of the above sub-categories of effects on neighbors were found to be roughly equivalent when applied to the various site options. Although there were perceived imbalances of effects under some of the sub-categories, imbalances against one site under one sub-category tended to be neutralized by imbalances against another site in another sub-category. For example, imbalances found against the use of Long Island for either all secondary or mixed alternatives due to the additional cost of the traffic mitigation measures of repairing or replacing access bridges tended to balance out against the additional cost that might be required for noise mitigation on Deer Island, particularly if the House of Correction was not removed.

Similarly, the imbalance against Long Island caused by the determination that more substantial odor effect was likely on potential recreators was balanced against the possibility for greater negative visual impacts on residential neighbors from a treatment plant on Deer Island if the House of Correction was not removed. In sum, when all the effects were weighed within the sub-categories and the total effects of each sub-category were weighed one against the other, the MWRA concluded that the criterion of effects on neighbors, as a whole, was not site-determinative.

### 3.2.2 EQUITABLE DISTRIBUTION OF REGIONAL IMPACTS

Equitable distribution of regional impacts was adopted by the MWRA as an additional criterion in response to the issues of fairness raised in the comments on the SDEIS/DEIR. The criterion brought into the decision process considerations of how many and what kind of impacts a community might already bear from proximity to regional facilities other than the contemplated treatment plant. For example, impacts on Winthrop from Logan Airport, the Deer Island House of Correction and the current Deer Island treatment plant were reviewed, as were the effects on Quincy of the existing Nut Island treatment plant and flight patterns from Logan Airport. Distinctions were made between regional uses that provide little benefit to the community impacted (such as Logan Airport vis-a-vis Winthrop) and those regional facilities which daily serve a number of residents of the impacted communities (such as MBTA stations in Quincy). It was further noted that the impact from the latter use was mitigated by the existence of a local-aid fund which provides some monetary reimbursement to host communities.

The consideration of regional use burdens on potentially impacted communities had two applications in the preferred alternative siting decision. First, there was an assessment of whether or not the cumulative regional burdens on any one particular community would be so excessive if the treatment plant were sited nearby as to require, without regard to any other criteria, that the treatment plant be sited elsewhere. One decision-maker concluded that the cumulative and long-term burdens imposed on Winthrop currently and in the past required a decision to site the treatment plant at a location other than Deer Island. Other decision-makers decided that the degree of unfairness did not rise to the level of unilaterally precluding the siting of the treatment plant on Deer Island.

The second way in which the criterion of equitable distribution of regional impacts was applied was to broaden the scope of factors to be considered in assessing effects on neighbors and in determining the nature and degree of mitigation measures to be undertaken. As to the former, the impacts of other regional uses were evaluated not only separately, for their effect on the community, but as they might combine with the noise, odor, and other impacts of the proposed treatment plant.

In assessing the impact of regional facilities on the various communities, the MWRA concluded that the choice of any of the alternative site options was unfair to whichever of the communities were impacted, by virtue of the burdens to be borne by those particular communities on behalf of so many other communities. When contrasting the relative regional burdens between the impacted communities, some decision makers noted that the greatest share of burdens for

regional impacts was already borne by the City of Boston and that Boston's burdens would be increased whichever option was chosen. Between the City of Quincy and the Town of Winthrop, the MWRA concluded that the greater number of regional burdens borne by Winthrop made it more unfair to Winthrop to locate the plant on Deer Island than it was unfair to Quincy to locate the treatment plant on Long Island.

### 3.2.3 COST

From the outset of its deliberations, the MWRA considered cost to be an important criterion. One of the first tasks the MWRA undertook was to closely examine the previous cost estimates which had been included in the 1982 MDC Site Option Study and the SDEIS/DEIR. Those cost estimates and a new set of estimates prepared by MWRA's consultant were analyzed and discussed both as to the absolute dollar figures presented and as to the relative differences in costs between sites.

Following the initial presentation to and discussion of these figures by the MWRA, consensus was reached by the various cost estimators which reduced the range of difference among them by half. The MWRA reviewed the original figures, the new figures, the basis for each and the rationale for the differences. It recognized that the figures could be firm to only a certain degree, given that a site was being selected prior to any facility design being undertaken. The MWRA chose to consider the higher figures in the range as better representing the most conservative case for design and construction needs and choices, including but not limited to greater assurances of reliability through increased redundancy and mechanical backup.

At each stage of development of the cost figures, the MWRA determined whether the differences changed the ranking or rating of the site alternatives or the relative differences between the alternatives appearing in the SDEIS/DEIR. As to the first two stages of development in cost estimates described above, the MWRA concluded that the ranking or rating of alternatives remained the same and the relative difference between the sites remained constant no matter which estimates at which level of refinement were used.

However, as the deliberations of the MWRA with respect to the other criteria continued, it became evident that cost was closely intertwined with assessments of those criteria and constituted an important factor for each item evaluated. As a result, further discussion and inquiry on costs were undertaken by the MWRA, and a third and more detailed cost analysis was produced. The resulting figures were reviewed and discussed by the MWRA. It was determined that while the new figures narrowed the difference in cost between some of the options involving Long Island and some of the options involving Deer Island, it did not change the ranking of any of the site alternatives.

The MWRA also developed and discussed a comparison of costs between Deer Island and Long Island with and without the existing institutions. The MWRA concluded that in all cases, it was less costly to construct the treatment plant on Deer Island as compared to constructing it on Long Island. It further determined that it was less costly to construct the treatment plant on either of the islands without the respective existing institutions being present.

### 3.2.4 IMPLEMENTABILITY

The MWRA utilized the implementability criterion to assess how quickly and how predictably the treatment plant could be completed at each of the alternative sites. This included a review of the requirements for and potential impediments to obtaining the real estate necessary for the construction of the treatment plant under the various alternatives. After examining the ownership and the means by which that ownership could be transferred, the MWRA concluded that obtaining the required land under all the options was roughly equal in terms of the legal steps to be taken and the likelihood of success.

The MWRA also reviewed the various permits, licenses and approvals that would be required from federal, state and local authorities in order to build the treatment plant under the various site plans proposed. It found that most of the state and federal permits required were equally applicable to Deer Island and to Long Island. It noted that burial grounds and archaeological/historical properties were a significant issue with respect to Long Island and would probably require extensive mitigation efforts, but also took into account that Deer Island had historic resources that might require consultation with authorities and possible mitigation. Similarly, the MWRA examined the conclusion of the SDEIS/DEIR that the permit issues surrounding burial grounds principally impacted Long Island, but also noted the possibility that they might be involved with Deer Island as well. With regard to the loss of historical or archaeological resources, the MWRA gave weight to the fact that the necessary consultation, mitigation and approval process for whichever island was selected could be engaged in concurrently with the facility planning and design process for the treatment plant, and would not greatly delay the construction of the facility. It was also considered important that this approval process, while requiring consultation and mitigation, could not prohibit the construction of a treatment plant on either island.

Further implementability issues that might apply to only one of the islands, or might be more difficult on one island as compared to the other, were examined. These included wetlands, order of Conditions, bridge construction, barrier beaches, opening of Shirley Gut, air quality questions, possibility of contaminated dredge spoils, existing grit and screenings, hospital relocation and House of Correction relocation. The first three of these issues were thought to have more certain application to Long Island but were considered to have possible application to Deer Island as well. The middle three issues were looked at as possibly raising additional or more difficult issues in the case of Deer Island. Air quality issues were discussed with EPA, and further information obtained by the EPA indicated to the MWRA that the treatment plant could be located at either island without violating national ambient air quality standards for air pollution under the configurations being considered by MWRA and by EPA.

Implementability of relocating the existing institutions on Deer Island and Long Island was scrutinized very closely by the MWRA. The MWRA heard and considered presentations by legal counsel to the City of Quincy and the Town of Winthrop on the need for and comparative legal difficulty of relocating the institutions. The MWRA also received and evaluated communications from the Governor of the Commonwealth, the Mayor of the City of Boston and the Speaker of the Massachusetts House of Representatives. The MWRA concluded that, as to real estate and permit approval issues, the various site options balanced out with respect to implementability. The

removal of the House of Correction from Deer Island, however, was felt by the MWRA to be more feasible than removal of the Long Island Hospital, considering the commitments made by the authorities who would be in a position to implement the respective relocations.

### 3.2.5 RELIABILITY

The MWRA viewed reliability as the concept of enhancing the overall integrity of the waste treatment system. Information was received on such factors as minimization of detrimental consequences of outages, operational capabilities during and after construction, managerial enhancement and technological reliability. Particular issues of reliability were explored in more detail. The performance of a secondary treatment system was reviewed at some length with stress on the need for proper design to handle such things as variable loads and intake of septage to prevent a malfunctioning of the system which would result in partially treated sewage being released into the harbor through a short outfall. The reliability of tunnels was reviewed, and the use of round versus rectangular clarifiers was discussed. Also considered was the need for backup in the case of catastrophic outages.

With regard to clarifiers, the Board heard that circular clarifiers were considered more reliable by some and that use of those clarifiers would require a greater acreage and expenditure to install, but it also heard that a comparable degree of reliability could be provided by rectangular clarifiers, which use less space and are less costly. The MWRA determined that either type of clarifier could be utilized under the various site options being considered.

The greater or lesser use of tunnels under any particular site option was considered to be an insignificant factor since it was determined that reliability of tunnels could be assured through proper design and maintenance during construction and operation. There was a recognition that those site options with split plants would provide greater reliability in the case of catastrophic outages, but this fact was determined to be offset by the consideration that such outages could be expected to occur at very infrequent intervals and that the ability to achieve reliability at split plants would be more costly because of the need to provide two sets of administration and staffing.

In assessing the various site options in light of reliability factors, the MWRA concluded that, while reliability was a very important consideration in constructing and operating the wastewater treatment plant, it was not a determinative factor in selecting site options between Long Island and Deer Island. Reliability was viewed by the MWRA, however, as a very important factor in its relationship to impact on neighbors. Any reduction of efficiency or increase in operational malfunctions would potentially create greater negative impacts, such as odors, on the neighborhood. It was also recognized and considered an important factor that the capital cost of the secondary treatment plant would be greatly increased by the design and engineering which would be necessary to protect against the greater unreliability inherent in a constrained site. Also, higher operational and maintenance costs would have to be anticipated as a result of the more complex design that would be required.

Weighing all these factors, the MWRA concluded that greater reliability would be obtained in any of the secondary treatment plant options if the respective existing institutions were

removed and, conversely, that reliability would be severely impacted if the secondary treatment plant was built without removing the respective institutions. In any other regard, reliability was considered to be equally obtainable at all site alternatives considered and therefore not site-determinative.

### 3.2.6 HARBOR ENHANCEMENT

The MWRA's view of harbor enhancement incorporated compatibility of the proposed treatment plant with attainment of the harbor's potential. The MWRA reviewed the site alternatives not only with respect to how each site option might serve as a source of impact on the Harbor but also as to how each option might serve as an opportunity for achieving the objectives listed. This information for the site options -- as they related to one another and to the Harbor as a whole -- was then considered.

Certain concerns of the MWRA were further explored. The potential for recreational use of Deer Island was reevaluated and discussed. As a result, the MWRA accorded greater weight to the recreational potential of Deer Island than had been previously assigned to it in the SDEIS/DEIR. The MWRA concluded that the recreational potential of Deer Island and of Long Island, absent any development, was similar in a number of ways with many of the same types of activities potentially available. Two differences were found to favor the preservation of Long Island's recreational potential, however. The first was the greater potential for public swimming beaches at Long Island. The second was the wilderness experience derived from the wild vegetation in the undeveloped parts of Long Island which, once destroyed, could not be recreated elsewhere.

The two islands were also reviewed for compatibility of recreational use with a treatment plant present. If the existing hospital were retained along with the treatment plant, Long Island would lose the significant recreational potential of Long Island head but might retain its barrier beaches, whereas if the existing House of Correction were retained, Deer Island might be able to encompass a small naturalized park located at Deer Island head. If neither existing institution remained along with the treatment plant, a park at Long Island head and an environmental study area in the southwest of Long Island could possibly be preserved, while at Deer Island, a neighborhood park and a regional park could be created and the natural beaches preserved.

It appeared to the MWRA that the quality of recreation on the islands -- co-existent with a treatment plant but without the existing institutions -- was higher for Deer Island than Long Island. At Deer Island, existing or man-made landforms could screen recreational areas from nearby receptors. At Long Island, the treatment plant would be highly visible, and the wind patterns might carry the odors over Long Island head a significant amount of the time. In balance, the MWRA felt that greater recreational potential for the harbor would be available by building the treatment plant on Deer Island rather than Long Island with or without the existing institutions, but particularly in the latter case.

The MWRA also considered implementability of recreational plans. It was noted that Long Island was physically ready to be developed for recreational use almost immediately if no treatment plant were sited there, but that a much longer time would elapse if recreational use had to wait until a treatment plant was operational on Long Island and the Deer Island treatment plant subsequently removed. The availability of funds for recreational development of Long Island as an already established priority in the Boston Harbor Islands Park system enhanced the likelihood of recreational development of Long Island in the near future.

In assessing the visual effect of the various treatment plant site options, it was determined that the primary and secondary treatment plant options at Long Island were deemed to produce the most radical changes to the natural terrain and to impact the most negatively on the harbor as a whole.

Having reached the above conclusions and having evaluated the information contained in the SDEIS/DEIR, the MWRA concluded that harbor enhancement would be promoted by the preservation of Long Island as a potential park resource and, conversely, that the harbor would be diminished both visually and for recreational purposes, if the treatment plant were constructed on Long Island.

### 3.2.7 EFFECT ON NATURAL AND CULTURAL RESOURCES

The MWRA examined the natural and cultural resources that would be impacted by each of the site option alternatives. In addition to the information contained in the SDEIS/DEIR, summaries further distilling the information and updated reports of ongoing evaluations of the sites by the Massachusetts Historical Commission were heard and evaluated. The MWRA not only considered the number and significance of historical, cultural and archaeological structures and sites, but also the degree of mitigation that might be required if such places and things were disturbed. The possible effect of any mitigation measures on duration and cost of construction was then assessed. The MWRA also gave some weight to the nomination or intended nomination of those items to the National Register of Historic Places.

The MWRA took into account the number of archaeological sites in existence, the rarity and integrity of such sites, the contribution of such sites to an understanding of our history, and the quantity of material contained in the sites. It was noted that no archaeological sites had been uncovered at Deer Island, but the MWRA also took into account that there had not been as thorough a survey of parts of Deer Island as there had been for the whole of Long Island. Nevertheless, in reviewing the five prehistoric sites uncovered at Long Island, the MWRA determined that their preservation deserved stronger consideration in the choice of a site.

With regard to cemeteries, the MWRA contrasted the existence of several cemeteries on Long Island with the possible existence of a cemetery on Deer Island. Again, however, it noted that Deer Island had not been as intensively surveyed as Long Island. It noted that Long Island in its entirety was being considered for nomination as part of the Boston Harbor Archaeological District. The MWRA concluded that the existence of cemeteries was not as significant as the existence of archaeological sites since the cemeteries could be moved and preserved elsewhere.

Although the movement of graves raised implementation issues, those issues were the same for each island and were not considered to be impossible to overcome.

The MWRA also reviewed the potential eligibility of the Long Island Hospital, the Deer Island House of Correction, and the Deer Island pumping station for listing on the National Register of Historic Places.

Finally, the MWRA reviewed the natural resources of the two islands. While little or no adverse impacts to the natural resources on Deer Island were found, with the exception of the removal of the drumlin on Deer Island in the case of a secondary treatment plant being sited there, it was determined that the wetlands and barrier beach at Long Island might be adversely affected by the construction of either a primary or secondary treatment plant even if strict controls were imposed. Concern was expressed that even a split secondary option would impact on sensitive areas on Long Island. In sum, the MWRA concluded that the least negative impact on natural resources would be achieved by selecting Deer Island for an all-secondary or all-primary wastewater treatment plant.

### 3.2.8 MITIGATION MEASURES

The MWRA used the criterion of mitigation measures to focus on and clearly consider those actions which might be or ought to be taken with regard to a particular site to make that siting choice environmentally acceptable, and to assure to the greatest extent feasible that negative impacts from the siting selection would be alleviated or compensated for. The MWRA considered both environmental and non-environmental measures.

#### Environmental Mitigation

Environmental mitigation measures were considered to be those steps which would minimize adverse impacts from the construction and operation of the treatment plant.

Construction impact mitigation measures reviewed included barging, land modifications and buffers, scheduling and specifications for equipment to reduce noise impact, and monitoring and response mechanisms to oversee and enforce construction mitigation efforts.

Operations impact mitigation measures examined included the use of technology, design and buffers to reduce noise, odors and visual impacts on residences, institutions and/or recreators, as well as adaptation of site layouts and monitoring mechanisms to ensure proper operation and maintenance of the treatment plant and to assure responsiveness to changing conditions.

Most of the environmental mitigation measures were explored not only separately but as part of discussions involving reliability, effect on neighbors, cost, site layouts and effect on natural and cultural resources and are addressed to varying degrees under each of those topics in the FEIR. The MWRA articulated throughout these discussions a strong commitment to environmental mitigation, particularly as it would reduce negative impacts on the nearby receptors. It also recognized, however, that the extent of the mitigation employed would be

determined, in part, by balancing the cost to the ratepayers against the degree of mitigation to be achieved. In some cases a determination was made that certain amounts or kinds of mitigation would be undertaken regardless of cost. For example, it was decided that stringent odor controls would be employed no matter where the treatment plant was constructed. It was also determined that a significant degree of barging was required for the transportation of construction equipment and materials.

Most of the environmental impact measures considered were deemed applicable in some degree to all sites, but some measures were found to be required more frequently or to a greater degree under one site option or another. For example, the environmental mitigation measures to be employed when disturbing cultural or natural resources were perceived to be required more often and to entail more effort at Long Island than at Deer Island due to the greater number and value of sites located at Long Island. Balanced against this was the greater impact of noise on Deer Island neighbors and the resulting need for additional mitigative measures. The MWRA concluded that the individual environmental mitigation measures or the degree to which those measures might need to be applied differed from site option to site option but that, when all the mitigation measures for a particular site were totaled and balanced against all the mitigation measures required for another site selection, the environmental mitigation measures tended with one exception to balance out and not to be site-determinative. The exception pertained to the split plant options which would require the implementation of mitigation measures at two sites instead of one, with a substantial increase in cost. The MWRA considered this a factor to be weighed against selection of the split plant options.

The MWRA did decide that mitigation measures, while not being site-determinative between all Deer Island and all Long Island, were of critical importance with respect to whichever site it chose. Consequently, MWRA voted just prior to selecting its tentative preferred alternative site, that its FEIR for siting the Harbor Islands treatment plant should include a complete discussion of all practicable means and measures to minimize damage to the environment in connection with construction of the new sewage treatment facility including but not limited to (i) barging of construction material and personnel, (ii) limitations on unnecessary construction period traffic, (iii) controls on construction noise, (iv) controls on operating noise and odors, (v) visual enhancements of the site, (vi) alternatives to through-neighborhood trucking of chlorine for purposes of facility operations, (vii) construction of deep ocean outfalls, and (viii) development of compatible recreational uses on the site and elsewhere in Boston Harbor. The Board also voted on the day it made its tentative preferred alternative selection that it preferred that sludge management facilities be located off-site from the treatment facility.

Non-Environmental Mitigation

The MWRA considered non-environmental mitigation to be an important consideration in the siting decision and a necessary adjunct to the construction of a treatment plant of the size and complexity planned. Non-environmental mitigation measures examined were the opening of Shirley Gut, which would physically isolate Deer Island from the mainland, rehabilitating or reconstructing access bridges, development of recreational or other multi-use possibilities for the sites considered, protection against future facility overload, assurances of plant operating performance, employment of innovative technology, and relocation of the existing

institutions. With respect to the measures reviewed, the ones determined to be site-specific were those concerning access bridges, opening of Shirley Gut, and relocation of the existing institutions.

As discussed in the text regarding the criterion of effect on neighbors, the MWRA evaluated the comparative difficulty and cost regarding rehabilitation or replacement of access bridges and determined that it would be more costly to repair, replace or construct new bridges for access to Long Island.

After examination of the geologic processes and currents affecting Shirley Gut, the need for and high cost of maintenance to keep the Gut cleared, the numbers of regulatory requirements for undertaking such a project and the possibility that its being opened would result in greater nearshore pollution and perhaps permit movement of polluted waters from Boston Harbor through the gut to the eastern shores of Point Shirley and Winthrop, the MWRA determined that the opening of Shirley Gut was not a feasible mitigation measure and that other means of separating Deer Island from the mainland should be considered if a need for separation were determined necessary or desirable.

The relocation of the existing institutions was determined by the MWRA to be a critical non-environmental mitigation measure. This conclusion resulted from the MWRA's evaluation of: the effects of noise, odor and visual aspects of the treatment plant on the persons working in or inhabiting the institutions; the reduction in reliability which would result from construction of the treatment plant on sites constrained by the presence of the institutions; the far greater construction cost and ongoing maintenance and operational costs which would result from having to construct the treatment plant on a constrained site; and the greater recreational potential which would be available for the harbor if the institutions were removed. With respect to cost, recreational potential and the effects of noise, the MWRA concluded that it was even more important to relocate the House of Correction than the Long Island hospital, since the negative impact from retaining the existing institution on the same site as the treatment plant was greater for Deer Island than for Long Island. The MWRA also determined that while regional impacts would be more equitably distributed by the relocation of either institution, more equitable distribution would result from the relocation of the House of Correction due to the nature of the respective institutions and the number and kinds of regional impacts already experienced by the Town of Winthrop. The MWRA further noted that property values were more likely to be increased in the Town of Winthrop by the removal of the House of Correction than those in the City of Quincy by the removal of the hospital, and that the health and safety of residents of the Town of Winthrop were apt to benefit by the relocation of the House of Correction.

In sum, the MWRA concluded that if either Long Island or Deer Island were selected, the existing institutions should be relocated. As between the two islands, the MWRA decided that it was more important and more beneficial to remove the House of Correction if Deer Island were selected than it was to relocate the hospital if Long Island were selected. Some decision makers felt that if Deer Island were selected, the House of Correction must be relocated. For these decision makers, the relocation of the House of Correction was not a mitigation matter but an action compelled by the other criteria.

In evaluating the removal of the institutions, the MWRA placed strong emphasis on the implementability of such a measure. It received and considered commitments made by those authorities empowered to and responsible for any such relocation and determined that the implementability of relocating Deer Island House of Correction was extremely likely -- far more likely than relocating the hospital.

As with environmental mitigation, the MWRA indicated its strong commitment to non-environmental mitigation by voting for the preparation of a complete discussion, for use by the Board of Directors, of proposed non-environmental mitigation measures for the construction of the Harbor Islands treatment plant including, but not limited to, construction workforce hiring preferences for residents of impacted communities, protection against diminished real estate values from nearby construction activities, preferential economic considerations for impacted communities, and funding for repair of bridges, roads or other physical infrastructure damaged by construction activities.

### 3.2.9 CRITERIA WEIGHING PROCESS

The MWRA concluded that while all the criteria were important, some criteria were of relative equivalent value when applied to the various site options and were not site-determinative. Those criteria were: reliability, effects on neighbors, and implementability, as well as the environmental mitigation part of mitigation measures.

The five criteria which the MWRA concluded were site-determinative were: cost, equitable distribution of regional impacts, harbor enhancement, effect on natural and cultural resources, and non-environmental mitigation. All the site-determinative criteria except equitable distribution of regional impacts weighed in favor of selecting Deer Island as the site for the wastewater treatment plant. While the considerations of fairness implicit in the equitable distribution of regional impacts were valued very highly by the MWRA, they were not sufficient, by themselves, to outweigh the considerations of cost, harbor enhancement, effect on natural and cultural resources, and non-environmental mitigation measures.

In addition to determining which island should be the site for the construction of the Harbor Islands wastewater treatment plant, the MWRA concluded that whichever island was chosen, any existing institutions on that island should be removed. It based that conclusion on the results of applying the criteria of reliability, cost, harbor enhancement, effects on neighbors, and mitigation measures. Furthermore, the MWRA found on the basis of cost, equitable distribution of regional impacts, effects on neighbors (health and safety)*, harbor enhancement, implementability, and mitigation measures (non-environmental) that Deer Island without the House of Correction was the best site configuration considered. For some decision-makers, these latter criteria compelled the conclusion that if Deer Island were to be chosen as the site for the treatment plant, the House of Correction had to be removed.

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* While health and safety issues originating from the construction and operation of a wastewater treatment plant were found not to be site-determinative, health and safety were considered to be enhanced by the removal of the House of Correction.

### 3.2.10 TENTATIVE SELECTION

On July 9, 1985, on the day prior to its selection of a preferred alternative site, the MWRA voted its determination that the cost of a new wastewater treatment facility would be enhanced if the facility could be constructed on a site unrestricted by another existing institution, and that the removal of any existing conflicting institution would effectively serve to mitigate the impact of the location of a new wastewater treatment facility on surrounding communities.

In addition, the MWRA voted to direct its staff to work with any and all elected or appointed officials for the purpose of expediting the removal and relocation of any other institution located on whichever island it ultimately designated as the preferred alternative site for the new wastewater treatment facility. It further instructed its interim Executive Director to take certain actions to implement its position.

On July 10, 1985, the Board of Directors of the Massachusetts Water Resources Authority, in two separate votes, each ten to one, designated Deer Island as its preferred alternative for the siting of a new primary treatment wastewater treatment facility and as its preferred alternative for the siting of a new secondary treatment wastewater facility for Boston Harbor. The designations were explicitly undertaken for the purpose of completing final environmental and other precommencement review and to serve as the basis for undertaking only such additional work in the nature of planning, design, site assembly and any other work as can be accomplished prior to the availability of the Final Environmental Impact Report.

### 3.2.11 FINAL SELECTION

The following is the text of G.L.C. 30 Section 61, Findings by the MWRA on the Selection of Deer Island as the Site for Wastewater Treatment Facilities in Boston Harbor.

> On February 3, 1986, the MWRA made its final selection of a site for the proposed harbor island wastewater treatment plant. The selection of Deer Island as the location for the new facility brought to a close eight years of evaluation, discussion, comment and refinement of siting issues. Most of the history of the process followed and information explored is contained in the Supplemental Draft Environmental Impact Statement/Draft Environmental Impact Report (SDEIS/DEIR) and the MWRA's Final Environmental Impact Report on the Siting of Wastewater Treatment Facilities in Boston Harbor (FEIR).
>
> In particular, the latter document details the decision process engaged in by the MWRA from its inception in early 1985 through to its tentative selection of Deer Island as the site for the wastewater treatment facilities in July, 1985. Since July, the MWRA has continued to gather information which it has published in the FEIR, has received and evaluated comments to the FEIR including the Secretary's Certificate of Adequacy, and has reviewed EPA's Final Environmental Impact Statement and comments submitted on that document. Based on this information and on its previous examinations and evaluation, the MWRA has made its final selection. The following sets forth the findings upon which that final site selection rests and the process by which it was completed.

## DECISION PROCESS

In addition to its prior deliberations leading to the tentative selection of Deer Island as a site for the harbor island treatment plant, the MWRA evaluated two new categories of information in making its final siting selection. The first, technical information collected or refined between the July 1985, decision and the publication of the FEIR, was presented to and discussed by the MWRA Board of Directors at a series of public board meetings held throughout the fall of 1985. During these meetings, the MWRA reviewed and approved the content of the FEIR and adopted commitments to major mitigation measures contained in that document.

The second category of information reviewed by the MWRA was public and official comment to the FEIR, including the Certificate of Adequacy issued by the Secretary of the Executive Office of Environmental Affairs. In addition, the MWRA staff reviewed the Environmental Impact Statement issued by the Environmental Protection Agency and the Board of Directors reviewed the comments to that document as well as a summary of relevant distinctions between the FEIS and FEIR.

The information thus gathered was then evaluated for its applicability to the method of decision-making to be used in the final selection, for the effect of the information on the application of decision criteria to site options and for its effect on the mitigation measures to be adopted by the MWRA. A summary of that evaluation follows.

## DECISION-MAKING METHOD

### Selection of Criteria

The MWRA chose to maintain the eight criteria utilized in its tentative site selection process: Reliability, implementability, harbor enhancement, impacts on cultural and natural resources, costs, effects on neighbors, mitigation and equitable distribution of regional responsibilities. These criteria had been selected originally by the MWRA in response to the decision process carried out through the SDEIS/DEIR and the comments on that process. The Secretary of Environmental Affairs ("Secretary"), in his Certificate of Adequacy on the FEIR ("Certificate") approved the use of Equitable Distribution of Regional Responsibility as a means of assessing the more emotional, unquantifiable aspects of siting but opined that mitigation was better addressed only after a siting selection and not as a part of the siting decision process. As to the latter, the MWRA found that the use of mitigation as a criterion in arriving at a site selection had served a useful purpose and had contributed a focus different from the discussion of mitigation after a site was selected and that it was better to continue the decision process as already begun rather than making a major shift in the use of criteria at the culminating point in the decision process.

Weighing of Criteria

The Secretary's Certificate on the FEIR had recommended that each criterion be assigned a relative importance in the final decision. The MWRA reviewed the eight criteria selected and determined that they should be given equal weight as compared to each other.

Site Options

The MWRA, in reviewing the information gathered in light of the criteria utilized, found that a number of earlier determinations made in its tentative decision process should remain intact. Some of these determinations, once confirmed, served to eliminate certain site alternatives from consideration. For example, the MWRA confirmed its earlier tentative site decision that Nut Island was unacceptable for the construction of a treatment plant of the size contemplated, particularly with the filling of Quincy Bay which would be required. The Secretary's Certificate had acknowledged and found this conclusion to be acceptable, and other comments had only served to support this position.

The MWRA also confirmed its tentative decision that the four split plant options be rejected on the grounds that only the criteria of reliability and equitable distribution of regional impacts favored the selection of any of the split plant options, while the concerns encompassed in the remaining criteria were adversely affected by those alternatives. For example, the split island options would be more costly to construct, operate and maintain; would cause aggravated impacts to a wider universe of neighbors -- thus causing the need for greater mitigation; would be more difficult to implement because of the need to obtain approximately twice as many permits; and did not significantly lessen the impact of single island alternatives on cultural or natural resources or harbor enhancement. There was no additional or different information presented to persuade the MWRA to change this position.

As a result of these findings concerning site alternatives, the MWRA was left with a comparison of all Long Island and all Deer Island as possible sites for the harbor facility. A summary of the analysis of these two site alternatives in light of each of the criteria used and the information gathered as it affected those criteria, and the conclusions reached, follows.

## APPLICATION OF DECISION CRITERIA TO THE ALL LONG ISLAND AND ALL DEER ISLAND SITE ALTERNATIVES

### CRITERIA WITH NO SITE DETERMINATIVE EFFECT

In examining Long Island and Deer Island in light of the eight criteria, the MWRA found two criteria, reliability and effects on neighbors, to be of relatively equivalent value and therefore not to be site determinative.

Reliability

The MWRA had previously found reliability to be non-site determinative in its tentative decision because the size and configuration of each of the islands presented the same potential for use of design and layout to provide for reliability of the waste treatment system. The MWRA, in its current evaluation on reliability, noted that no new information had been presented to change that determination and confirmed its earlier decision.

Effects on Neighbors

The MWRA also found the effects on neighbors to be roughly equivalent between the two islands. As before, effects on neighbors were reviewed in six components: traffic impacts, noise impacts; odor impacts; visual impacts; property value impacts and safety impacts.

Traffic

Following its initial determination that the traffic impacts were comparable between the two sites, the MWRA commissioned a study to augment information provided in the SDEIS/DEIR traffic analysis. This analysis examined roadway conditions, assembled traffic counts, determined the present level of service on the roadways (LOS), and evaluated the impact of expected construction traffic. The MWRA concluded that for the predicted level of construction related traffic there was sufficient roadway capacity leading to each site during peak hours and that the impact although somewhat worse at some intersections for access to Long Island, was relatively comparable.

The MWRA also further explored the feasibility of barging, identifying the types of barging and/or water transportation that might be needed and sites that could be utilized. The MWRA made commitments to a level of barging, to caps on construction-related traffic and to busing of workers, all of which is set out in the Commitments to Mitigation section below.

The MWRA reviewed traffic-related comments received on the FEIR. The MWRA concluded, based on its original evaluation and the additional traffic information and comments collected since its tentative decision and its strong commitment to mitigation measures, that the traffic impacts remained roughly equal and did not favor either island.

Noise

The MWRA, in its tentative decision, adopted the then current position of EPA that noise levels at Deer Island would result in greater impact to neighbors, particularly the close neighbors at the House of Correction. However, that position was predicated on EPA's view that Long Island as a site for the treatment plant could not contain the Long Island hospital whereas the Deer Island site could encompass the House of Correction.

The MWRA in its final selection compared the sites equally, i.e. both sites with existing

institutions and both sites without those institutions. The MWRA concluded that when the sites without institutions were compared, there was more noise impact on neighbors at Deer Island than at Long Island. If the sites were compared with the institutions present, then the severity of impact on the residents or workers at each institution was equivalent.

To explore whether noise levels at Deer Island could be kept at acceptable levels, the MWRA retained an acoustical consultant to evaluate expected noise levels during both construction and plant operation for the Deer Island site. The consultant also furnished information to the Board on existing acoustical conditions, applicable regulations and an evaluation of the expected effectiveness of noise mitigation measures.

The MWRA concluded that for the nearest residence the noise levels from both construction and operation were within applicable legal standards. Furthermore, during the daytime the projected noise would be indistinguishable as compared to the existing ambient levels. At night, with a minimum of construction to be anticipated, nighttime noise would not be an impact. During plant operation, if power was generated on-site, a slight increase in background levels over existing levels was determined to be likely.

Based on this information and upon review and assessment of comments on noise, the MWRA concluded that while noise impacts upon receptors other than the current institutions would be greater at Deer Island, those impacts could be maintained at acceptable levels. The MWRA also found that the noise impacts at Deer Island prison or Long Island Hospital, because of the proximity of those institutions, would raise the noise levels above the legal standard and would require extraordinary mitigation measures to be adopted.

Odor

Odor studies conducted on behalf of the EPA have indicated that potential odor impacts on neighbors are comparable, regardless of plant location. This confirmed the MWRA's tentative decision that the issue of odor was not site determinative. The MWRA further recognized that odor control was a paramount concern and that stringent odor controls would be utilized no matter where the treatment plant was located. As a result of further work presented since its tentative selection, the MWRA concluded that control stystems such as wet scrubbers and carbon absorption columns would likely be effective in controlling the odors. The MWRA confirmed its tentative decision that odor impacts were not site determinative and committed itself to a limit of no detectable odor off-site as well as a goal of no objectionable odor on-site.

Property Values

Reviewing trends in real estate values and the impacts of other noxious facilities on property values, the MWRA confirmed its tentative decision that the effect on property values, to the extent that that effect could be predicted, was not site-determinative.

Visual Impacts

In its tentative decision the MWRA determined that a treatment plant on either island have a negative impact on persons in the existing institutions due to proximity. With respect to residential neighbors, it was determined that if the institutions remained, there would be a somewhat greater negative impact from a treatment plant on Deer Island. If the House of Correction were removed, however, modifying land forms and landscaping could be used to screen the treatment plant from most residences.

Health and Safety

Health and safety concerns of the community -- such as traffic impacts on schools and the elderly, chlorine delivery, air quality reduction from traffic or the facility operation -- were examined and found once again not to be site-determinative factors.

Summary of the Effects on Neighbors

Most of the effects considered within each of the subcategories of effects on neighbors were found to be roughly equivalent between Long Island and Deer Island. For those two categories in which a somewhat more negative impact was discerned for Deer Island, noise and visual impact, the degree of difference in impact was not sufficient to change the balance of effects on neighbors between the two sites.

SITE DETERMINATIVE CRITERIA

The MWRA found the remaining six criteria to have a site-determinative effect. Five of the criteria favored the selection of Deer Island while one criterion, equitable distribution of regional responsibilities, favored the selection of Long Island. A summary of that analysis follows.

Equitable Distribution of Regional Responsibility

Just as in its tentative decision, the MWRA found in its final site selection that this criterion favored the selection of Long Island over Deer Island. The impacts of other regional uses such as Logan Airport, Deer Island House of Correction and the current Deer Island treatment plant were found to have greater impact on Deer Island neighbors than the airport and other regional facilities had on Long Island neighbors. The MWRA concluded that it was more unfair to site the harbor facility at Deer Island.

Cost

The MWRA again found this criterion to favor selection of Deer Island. There was no change to the cost information upon which the MWRA had made its tentative decision. Those figures still showed the construction of a treatment plant on Deer Island to be less costly than a facility at Long Island. While noting that EPA had found this criterion to

be non-site determinative and that the Town of Winthrop had concurred with this conclusion, the MWRA recognized that this reflected a value judgment by the EPA and Winthrop of the relative unimportance of the dollar difference which both EPA and MWRA agreed existed rather than different information as to the cost figures themselves. The MWRA, as the operator of the system felt that the difference in cost between the two sites was of site significant importance.

Implementability

In its tentative decision, the MWRA found implementability to be non-site determinative. The information which the MWRA had reviewed at that time covered the permitting and land acquisition issues and, based on the assessment that the numbers and types and timing considerations of permits and approvals were generally the same, had concluded that the criterion was relatively equivalent between the sites. The MWRA also noted at that time that the removal of the House of Correction from Deer Island was far more implementable than the removal of the hospital from Long Island due to the expressed support for the former by those in a position to effect the removal.

Two factors have been added to the implementability discussion since the tentative decision, however, which have caused the MWRA to change its conclusion about this criterion. The first is the concurrence in the approval by the Secretary of the selection of Deer Island as the site for the treatment plant. The second is the selection of Deer Island by the EPA as its preferred alternative. The choice of Deer Island as the preferred site by both a state regulator and a federal regulator, each of which has responsibilities in further permitting or approvals concerning the construction and operation of the treatment plant and related facilities, increased the likelihood of successful and expeditious processing of the many regulatory reviews and permits pertaining to the Deer Island site. It also suggests a facilitating of the disposition of federal land located on Deer Island. In light of these factors, the MWRA has found in its final siting decision that implementability is no longer non-site determinative and that it weighs in favor of selecting Deer Island.

Harbor Enhancement

A further exploration into recreational potential of Deer Island conducted during the tentative decision process was completed for the FEIR and confirmed what had already been suggested during the tentative decision process: that a greater potential existed for Deer Island than had been suggested in the SDEIS/DEIR. However, the possibility of this greater potential had been discussed when the MWRA made its tentative selection and its confirmation did not change the MWRA's determination that harbor/enhancement favored siting the treatment plant at Deer Island. The MWRA still found that Long Island's recreational resources included natural and undeveloped aspects which could not be recreated if lost; that Long Island as a park could be brought to reality sooner since it did not have sited on it both a prison and a current treatment plant which had to continue operating until the new plant was on line; that there were indications that official support and dollars had already been or could readily be mobilized to make a park on Long

Island a reality; and, finally, that the adverse visual impact on the harbor was greater from a treatment plant on Long Island because of the Island's position in the harbor and its configuration.

Effect on Natural and Cultural Resources

In examining the natural and cultural resources of each island, the MWRA took into consideration additional pieces of information received since its tentative decision. In particular, the MWRA considered the results of a study, which it had commissioned, of parts of Deer Island which had never been adequately evaluated before for the existence of archaeological or historical resources. That study confirmed the existence of a cementery in the northeastern part of the island and also confirmed the potential eligibility of the Deer Island pump station and portions of the Deer Island House of Correction complex for nomination to the National Register. Subsequently, the Massachusetts Historical Commission found that the pump station, and two buildings in the prison complex met National Register criteria. In its comments on the FEIS, the Commission also noted that Long Island in its entirety had been nominated to the National Register as a component of the Boston Harbor Islands Archaeological District, that the Long Island hospital complex also met National Register criteria of eligibility and that historic burial grounds existed on Long Island.

All the information received concerning these resources was a confirmation of material already considered to be potentially true during the MWRA's tentative decision. The MWRA found, as it had in its tentative selection, that Long Island possessed more resources and more unique resources than Deer Island and that these resources, particularly the unique resources, would be adversely impacted by the siting of the harbor treatment plant facility on Long Island.

The MWRA noted that EPA had found this criterion to be non-site determinative but recognized that EPA had hypothesized layouts which could avoid these resources without fully exploring the technical feasibility of those layouts. The MWRA had assured that the layouts upon which their conclusions rested were technically feasible.

Mitigation

The MWRA utilized the criterion of mitigation to focus on and clearly consider those actions which might be or ought to be taken with regard to a particular site to make it more acceptable. The utilization of this criterion in the siting decision process brought to the fore and highlighted mitigation measures which might be site specific and permitted the MWRA to weigh the need for those measures in its siting selection. Early analysis of mitigation needs during the decision process also laid the groundwork for a thorough understanding and appreciation of mitigation measures to be adopted once a site was chosen. The mitigation measures to which the MWRA finally committed itself in the implementation of its site selection of Deer Island are contained in the Commitments to Mitigation section which follows.

With respect to the effect of the mitigation criterion in the siting selection process, the MWRA confirmed its earlier finding that mitigation favored the selection of Deer Island.

While various measures to mitigate construction and operation impacts such as noise and odor or the destruction of natural or cultural resources might shift the balance slightly toward one site or the other within each of those categories, the total number of kinds and degree of mitigation required for one site or the other tended, with one exception, to balance out roughly equal as a whole. The one exception was the mitigation measure of relocating the existing institutions. The MWRA found in its tentative decision and confirmed in its final decision that it was critical to relocate whichever existing institution was located on the chosen site due to the adverse environmental effects which accrued from constructing the treatment plant on a constrained site in close proximity to the particular institution. However, the MWRA also found that there was more net benefit to building the treatment plant on Deer Island and removing the House of Correction than building on Long Island and removing the Long Island Hospital since removal of the House of Correction would favorably affect property values and the safety of the currounding community and would promote equitable distribution of regional facilities. Further details as to the findings of the MWRA regarding the removal of the existing institutions and the Deer Island House of Correction in particular is contained in the Commitments to Mitigation section which follows.

Final Siting Decision

Having found two criteria effectively neutral between Long Island and Deer Island (Reliability and Effects on Neighbors), one criterion favoring the selection of Long Island (Equitable Distribution of Regional Responsibility) and five criteria favoring selection of Deer Island (Cost, Implementability, Harbor Enhancement, Effects on Natural and Cultural Resources and Mitigation), and having given each criterion equal weight, the MWRA determined that the most appropriate site for the harbor island wastewater treatment facility is Deer Island.

## COMMITMENTS TO MITIGATION

Recongizing the need to adopt all feasible measures to mitigate the adverse environmental impacts, the MWRA, as part of the FEIR, set forth a series of mitigation commitments designed to alleviate the impacts associated with the construction and operation of the Harbor Islands plant. During the process of making its final siting decision the MWRA reviewed the public comments on the proposed mitigation commitments and the comments received from the Secretary of Environmental Affairs and adopted a final series of mitigation commitments. This section sets out those commitments.

--Commitments on Flow and Growth
--Commitments on Plant Maintenance
--Commitments on Odor Control

--Commitments on Noise
--Commitments on Barging
--Commitments on the Use of Liquid Chlorine
--Commitments on the Relocation of the Deer Island House of Correction

Commitments on Flow and Growth

Recognizing the need for responsible management and being sensitive to the possible need for expansion of the proposed Harbor Islands treatment plant, the MWRA has made the following commitments with respect to flow and growth:

- The MWRA will undertake all necessary and prudent planning and management initiatives to avoid overloading the Harbor Islands treatment plant.

- The MWRA will not expand the treatment plant capacity unless or until it has implemented flow management techniques and has developed and implemented a program to avoid excess pollutant loading. These techniques and programs include:

    - Conducting infiltration/inflow reduction programs

    - Instituting water conservation programs that can reduce wastewater flows

    - Pricing of water and sewer services to promote the conservation of water, thus reducing wastewater flows

    - Controlling pollutant loads through pricing strategies and pretreatment programs

    - Controlling both flow and loads through regulatory controls, such as flow reduction programs to compensate for new connections

    - The MWRA will develop monitoring and triggering programs so that it will be able to test the effectiveness of the flow management techniques and to provide the MWRA with the ability to determine when planning for the MWRA's next increment of treatment capacity should be undertaken

- If the MWRA determines, through its monitoring and triggering programs, that the flows and loading are increasing at rates higher than projected in the FEIR, it will take all necessary steps to plan, design, and construct ancillary facilities including (but not limited to):

    - Flow control structures, such as on-line and off-line storage to minimize peak flows at the plant

    - Septage treatment facilities to reduce pollutant loadings on the Harbor Islands plant

- o If the ancillary facilities are insufficient to accommodate increased flow and loading and to prevent exceeding the design capacity of the Harbor Islands treatment plant, the MWRA will take all necessary steps to plan, design, and construct satellite treatment plants unless it determines it would be economically or environmentally infeasible to do so.

- o Notwithstanding the foregoing, the MWRA does not intend the adoption of the above commitments to require the postponement or cancellation of any capital program contained in the Authority's Fiscal Year 1986-88 capital budget that services to eliminate an existing problem of sewage backups.

The purpose of these commitments is to confirm the MWRA's desire to establish a sound and rational program for assessing future capacity needs, to respond to public concerns on overloading and future system expansion, and to provide a framework within which additional capacity will be planned.

Commitments to Operation and Maintenance

MWRA has already made clear its commitment to improved operations and maintenance by approving both a substantially increased operating budget and by authorizing significant increases in operations and maintenance staff for existing facilities. MWRA's commitment to maintenance is underscored by their adoption of the following assurances:

- o Review of Recurrent Budgets. Annual operating budgets will be carefully scrutinized to be certain that these budgets reflect not only a sound maintenance program for existing facilities but that the budgets reflect any new facilities expected to be in service during the budget year. The MWRA will link budget expenditures with performance indicators that reflect the efficiency and effectiveness of the maintenance programs.

- o Renewal/Replacement Expenditures. More than $100 million in construction projects have been initiated at the Nut Island and Deer Island treatment plants to replace much of the antiquated equipment at these plants. These upgraded programs are expected to be completed in 1989 and will contribute significantly to the reliability of the existing plant equipment. Capital budgets in future years will continue to reflect the important role that R/R plays in the maintenance of treatment facilities. The MWRA's maintenance procedures will be modified at an early date to incorporate record keeping procedures that will provide a rational basis for R/R investment in future years.

- o Review of Maintenance Procedures. Prior to the completion of the on-going upgrade program, the MWRA will initiate a review of its existing maintenance procedures. Strengthened maintenance procedures will be designed including an aggressive housekeeping and preventive maintenance program. These procedures will be amended as new treatment facilities are constructed.

- o Initiate Early Planning. To ensure that operations and maintenance considerations are included as an integral part of the planning for all new facilities, MWRA will require that the plant's facilities plan include a preliminary plan of operations. The preliminary plan of operations will identify the additional or unique O & M requirements of the recommended facilities, including staffing and special training needs, manuals, special tools and workshops, and estimated budget considerations. This preliminary plan of operations will provide MWRA with two to four years' lead time prior to completion of facilities to incorporate the maintenance requirements of new facilities into on-going maintenance programs.

- o Adoption of Performance Indicators. MWRA will adopt performance indicators into the agency's proposed management information systems that will permit the Authority to review on a regular basis the level-of-effort and the performance of the maintenance activities. Indicators such as plant performance, equipment availability, maintenance labor/expenditures, custodial inspection reports, spare parts inventory, and equipment age will be monitored to regularly examine the efficiency of the maintenance efforts. Additionally, the Authority will involve the community in reviewing maintenance programs to provide focus on issues of local importance.

Commitments on Odor Control

The MWRA commits to the construction of the treatment pant that will control odors so as to eliminate detectable odors off-site and to control odors as necessary to protect the public health. Furthermore, the MWRA commits to the control of odors so as to minimize, to the maximum extent feasible, objectionable odors on-site.

The type of odor control needed will be selected during the facility planning effort. Sampling of the odor potential characteristics of the influent wastewater will be conducted as part of the facilities planning to provide the necessary data to develop a program of source control and to size and select the odor control equipment.

The most reliable means of measuring odor performances is the human nose. In order to measure the plant odor performance, an odor panel will be created composed of individuals from the community as well as individuals from the MWRA. The panel will routinely monitor for odors to ensure that no objectionable odors are occurring off-site. The panel will also respond to odor complaints received by the plant, by assisting in the investigation of the odor and recommending odor control techniques.

Commitments on Noise Control

The MWRA is committed to complying with all the legal standards of both City of Boston noise control ordinance and the Department of Environmental Quality Engineering.

Because of the scale of the proposed plant, however, the MWRA is setting as a goal noise abatement that goes beyond simply adhering to the City of Boston code. The MWRA has

to define, by the FEIR, what noise levels may be achievable and will examine means of noise abatement throughout the planning, design and operation of the facility.

The MWRA further commits to the development of a program for avoiding adverse noise impacts, the components of which shall be resolved during facilities planning but which shall include the following:

- The establishment of an Acoustical Review Board. The Acoustical Review Board will include representatives from the community as well as engineers and MWRA staff.

- The use of available and feasible noise control techniques, which may include items such as the evaluation of the acoustical characteristics of operational equipment and flexible scheduling of construction activities to minimize noise.

- The establishment of necessary training and hiring practices to assume the best possible control of noise impacts.

- The involvement of the community in the development of noise control programs and the participation of community representatives in those programs.

Commitment on Barging and Busing

The determination that barging and busing are necessary is a direct consequence of the volume of traffic associated with the construction of the proposed facility and the limited capacity of roadways leading to the plant site. The Traffic section of the FEIR describes the capacity of the roadways. The commitment to barging, therefore, also requires a commitment to maximum traffic levels associated with the construction of the plant. Those traffic levels are defined for both the pier construction period and for the period thereafter.

Prior to construction of the piers, it is not feasible to barge materials to the site. Therefore, the MWRA has given a high priority to the identification of barge sites, design of pier facilities and construction of those piers. The Authority is engaged in the selection of a consultant for the necessary barge and pier facilities. The MWRA commits to limiting the trucking of materials for construction of the piers to a maximum of 20 trucks per day.

Upon completion of the pier facilities, the barging of almost all heavy construction equipment and materials is, based on the analyses conducted to date, an achievable level of barging. The level of commitment is conditioned, however, to allow for contingencies that may result from scheduling or operational problems. The extent of such contingency trucking, after the completion of the piers, will be limited to a service fleet of eight trucks. Also, in order to minimize impacts associated with commuting of construction workers to the plant site, the Authority has committed to the busing of all workers, using a maximum of 28 buses per day.

In addition, the Authority will undertake an evaluation of the practicality of providing ferries to transport construction workers to the job site.

Commitments on the Trucking of Liquid Chlorine

The MWRA has committed to cease the trucking of liquid chlorine through the streets of Winthrop as soon as possible when water access facilities become operable and the transport of alternate disinfectant or barging of liquid chlorine becomes feasible.

Commitment on Relocation of the Deer Island House of Correction

The MWRA has determined that the Deer Island House of Correction must be relocated from Deer Island by those parties with jurisdiction over its operation and that such relocation must be deemed a mandatory mitigation measure.

The MWRA's conclusion with respect to this mitigation measure is based on its findings throughout the tentative and final site decision process relative to the environmental impacts resulting from the construction of the harbor island treatment plant on either island with the existing institutions present, and the benefit to be gained by the removal of the existing institution from the island selected as the site for the treatment plant. Many of those findings, as they relate to Deer Island were addressed by the Secretary in his Certificate as well as by numerous commentors to the FEIR, all of whom found the relocation of the prison to be a required mitigation measure. The MWRA's findings on benefits which would result from relocation of the prison are summarized as follows.

The MWRA found that the reliability of the treatment plant would be greatly enhanced by providing sufficient space for optional design. The converse was also found, that building on Deer Island with the treatment plant present would require a cramped design with reduced space between piping and flow controllers resulting in decreased uniformity of flow and reduced control over the treatment process. This, in turn, would increase the possibility of operational malfunctions or decrease the ability to monitor or redress such episodes, resulting in adverse impacts on neighbors of the treatment plant.

The MWRA also found that building the treatment plant in such close proximity to the prison would cause severe visual and noise impacts on the persons living and working in that institution. The noise impacts on the prison would be above the legal standard and would require extraordinary mitigation measures to be undertaken to ameliorate the effect. Mitigation measures, such as buffers or berms, would place additional area demands on an already constrained site. Other measures, such as timing and placement of construction and equipment could adversely impact the length of construction time. Removal of the prison would eliminate such impacts and the need for such mitigation measures.

Relocation of the prison would also reduce costs. The cost of constructing the treatment plant on a constrained site with the prison present, of operating and maintaining the plant under those conditions, and of providing the necessary mitigation measures to

alleviate the proximity of the treatment plant to the prison would be significantly greater than building without the prison.

Finally, additional benefits to recreators and to non-prison receptors would accrue from the removal of the prison. Those benefits would include alleviating the visual impact of the treatment plant on Winthrop receptors by providing space for screening and modifying landforms, providing space for recreational and open land use, reducing traffic on Winthrop's streets by the approximately 114 autos a day currently used at the prison, substantially alleviating the combined impact of regional facilities on the Town of Winthrop and by enhancing the safety of the community.

For all these reasons and the reasons cited by the Secretary, some of which are echoed by other commentors, the MWRA considers the removal of the Deer Island House of Correction to be essential to the expeditious construction of new treatment facilities.

Further Measures to be Examined

The commitments to mitigation listed above comport with all mitigation measures which would be required under the MEPA statute. In fact, in many instances, as noted by the Secretary in his certificate on the FEIR, the MWRA has addressed many issues to a far greater degree than was required and has made commitments in these areas accordingly.

Nevertheless, the Secretary, in his final Certificate, has made recommendations that certain measures be undertaken either sooner than might be required or with respect to current facilities as opposed to the new treatment plant which is the subject of the FEIR.

The MWRA considers these suggestions positive and worthy of serious review. It has directed staff to evaluate the Secretary's suggestions and to recommend within thirty to ninety days where, when and how they may be responded to and the nature of the recommended response. The suggestions by the Secretary include:

1. The "Sewer Bank" concept be further explored and feasible programs developed to eliminate excess flow and accommodate new connections.

2. Accommodate future growth within the service area through satellite plants.

3. Continued and strengthened programs to monitor flows to provide sound data to gauge the effects of flow management.

4. Implement odor panel and formal odor complaint response at existing facility.

5. Consider real time monitoring of odors, perhaps using hydrogen sulfide as an indicator.

6. Consider development and implementation of a monitoring program for VOCs and other air toxics in the wastewater stream and in the ambient air.

7. Recommend implementation of an acoustic Review Board to monitor and respond to noise complaints at existing facility; and supplement such a noise program now and at the new treatment plant with periodic noise monitoring.

Summary of Impacts and Findings of Limitation of Impacts

The MWRA finds that the environmental impacts resulting from the construction of the Boston Harbor wastewater treatment facility are those impacts as described in the Draft Environmental Impact Report, elaborated on and refined in the Final Environmental Impact Report and commented upon in these G.L.C. 30, Section 61 Findings.

The MWRA further finds that its selection of Deer Island as the site for the wastewater treatment facility, and its commitment to the mitigation measure set out in the Commitments to Mitigation section of these G.L.C. 30, Section 61 Findings constitute all feasible measures to avoid or minimize the environmental impacts described.

Record of Decision

The text of EPA Region I's Record of Decision on the Final Environmental Impact Statement Siting of Wastewater Treatment Facilities for Boston Harbor is as follows:

The U.S. Enviromental Protection Agency (EPA) has prepared this document as its Record of Decision (ROD) for the Final Environmental Impact Statement (FEIS) on the siting of the Massachusetts Water Resources Authority (MWRA) wastewater treatment faciities which will abate the pollution of Boston Harbor.

The MWRA has the responsibility of selecting the site for the wastewater treatment facilities. EPA's primary responsibilities are to conduct an evaluation of environmental acceptability under the National Environmental Policy Act (NEPA), provide federal financial assistance if available, and ensure rapid compliance with the Clean Water Act.

EPA issued a Supplemental Draft EIS (SDEIS) in December, 1984 and a FEIS on December 2, 1985 on the siting of wastewater treatment facilities for Boston Harbor. These documents evaluated the environmental impacts of various site options for facilities to treat Greater Boston's wastewater in compliance with water pollution control laws. The SDEIS also served as a Draft Environmental Impact Report (DEIR) under the provisions of the Massachusetts Environmental Policy Act (MEPA) for the Metropolitan District Commission (MDC). Since publication of this joint document, the sewer functions of the MDC have been reorganized into the MWRA. The Board of Directors of the MWRA chose to follow an independent but parallel decision process and to publish a separate but concurrent Final Environmental Impact Report (FEIR) under state law.

Following the concurrent publication of EPA's FEIS and MWRA's FEIR, EPA and MWRA conducted joint public hearings before reaching their respective final decisions. Public hearings were held on January 13, 14 and 15, 1986 in Quincy, Boston and Winthrop. Oral and written comments were submitted during the comment period. The public comment period ended on January 21, 1986 for the FEIS and January 24, 1986 for the FEIR.

In February, 1986, the MWRA determined that "the most appropriate site for the harbor island wastewater treatment facility is Deer Island." This ROD identifies EPA's final decision on the siting issue. This ROD is being circulated to inform the public of this decision and to respond to the comments on the FEIS.

## I. EPA's FINAL DECISION ON THE SITING OF SECONDARY WASTEWATER TREATMENT FACILITIES FOR BOSTON HARBOR

With the understanding that EPA will require the MWRA to carry out the program of specified mitigation measures identified on pages 52-55 of the FEIS, Volume I, EPA's decision is that its preferred alternative is the All Secondary Deer Island alternative set forth in the EIS and described below. All Secondary Long (without the hospital) is also environmentally acceptable and is preferred over Split Secondary Deer-Long (without the hospital). The only alternative which EPA finds unacceptable is Split Secondary Deer-Nut. The decision process and the program of required mitigation measures is described in more detail in Section III.

EPA's preferred alternative for secondary treatment, All Secondary Deer, would expand the existing primary wastewater treatment facility at Deer Island to a secondary treatment plant. It would reduce the existing primary treatment facilities at Nut Island to a small headworks. It would include construction of a major new pipeline or tunnel from Nut Island to Deer Island and of an effluent outfall to the east of Deer Island Light. The existing wastewater treatment facility on Deer Island would be increased from 26 acres to about 115-140 acres while on Nut Island the existing wastewater facility would be reduced from 12 acres to about 2 acres.

This alternative would commit almost all the land on Deer Island south of the existing prison to wastewater treatment and level the most prominent topographic features of the island. This alternative would also require the construction of a bulk materials loading pier(s) and roll-on roll-off facilities at the site, and associated terminal(s) on-shore.

The estimated construction cost of this alternative would be about $1.135 billion and its annual cost of operation, maintenance and replacement would be about $50 million. Costs, acreage requirements, exact plant layout and mitigation measures will be developed in greater detail during further facilities planning on the project.

The Benefits of Moving the Prison

The MWRA favors a variation of the All Secondary Deer Island alternative which assumes that the prison would be removed as a mitigation action, and that its site would be made available for the treatment plant. This variation would also use most of the Island but prison removal would reduce the impacts of the treatment plant in several ways:

1. It would remove the receptor population (the prison workers and inmates most affected by the plant's impacts, including noise and odor).

2. It would eliminate prison-related traffic, thus offsetting construction-related and operations traffic for the treatment plant.

3. It would improve the appearance of Deer Island by removing the prison buildings.

4. It would permit opportunities for sculpting the landscape to a more natural appearance and for screening the facility from both the harbor and Point Shirley and Cottage Hill in Winthrop.

5. It would increase the opportunity for buffering noise at Point Shirley by earthen barriers on prison property.

6. It would permit the retention of a portion of the Island's shoreline for buffering and recreation.

7. It would remove prison-related anxieties from Winthrop.

8. It would make more land available for the wastewater treatment facility, possibly making construction and maintenance easier.

This variation does not eliminate the need for any of the mitigating actions proposed for the All Secondary Deer Island alternative with the prison to remain, except for those intended to reduce impacts at the prison itself, e.g., a noise barrier.

However, the process required to release the Deer Island prison site for treatment plant use could be so lengthy as to delay or frustrate the construction of this variation of the All Secondary Deer Island alternative. EPA has long advocated removal of the prison if Deer Island is to be the treatment plant site, but EPA will not require removal of the prison as a grant condition. Implementation of secondary treatment is required by the Clean Water Act and cannot be made dependent upon removal of the prison if the site is acceptable.

This ROD concludes that in EPA's judgement the All Secondary Deer Island Alternative is its preferred alternative and can be implemented without unacceptable environmental

impacts even if the prison remains.*

## II. SELECTION OF ALTERNATIVES FOR EVALUATION

Federal regulations require EPA, during environmental review, rigorously to explore all reasonable alternatives for the siting of wastewater treatment facilities for Boston Harbor. Most of the alternatives initially investigated were derived from the EPA's 1978 Draft Environmental Impact Statement (DEIS), which examined only secondary treatment options, and the MDC's 1982 Nut Island Site Options Study. The Site Options Study identified eleven alternatives (eight secondary and three primary treatment alternatives), including some previously examined in the DEIS. In September, 1983, EPA and the Commonwealth conducted two public scoping meetings to receive comments on these initial alternatives from the public and from federal, state and local officials. Upon completion of the joint scoping meetings, EPA selected eleven additional alternatives for analysis, for a total of twenty-two alternatives to be studied. These included twenty alternatives for treatment at Deer, Long, Nut, or man-made islands and two alternatives including sub-regional "satellite" plants. A complete discussion of the twenty-two initial primary and secondary alternatives appears in the SDEIS at Vol II, Section 12.12. Table I is a complete list of the twenty-two initial options.

[See Table I on page 3-38 in this Section.]

## III. DECISION PROCESS

To examine such a large number of alternatives, a screening process was developed jointly with the Commonwealth. Its objective was to narrow the number of alternatives being investigated and to eliminate those that clearly offered few benefits or had significant adverse impacts. This initial screening of alternatives is summarized here; it is described in detail the SDEIS. Each alternative's economic, social and environmental impacts were studied. In addition, their technical, legal, institutional and political problems were also analyzed. Specific criteria were developed for comparison and screening of the options.

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* The Clean Water Act requires that wastewater treatment plants be constructed which will provide "secondary" treatment unless EPA, under strict statutory guidance, grants a waiver, under Section 301(h) of the Clean Water Act, permitting a lesser "primary" degree of treatment with a deep ocean dicharge. EPA has twice denied the MDC/MWRA request for such a waiver but final rights of appeal have not expired. EPA believes it is highly unlikely any such appeal, even if pursued, would prevail on the merits, or that the discharge of primary effluent into Massachusetts Bay would ultimately be permitted over the opposition of the Governor and other officials. However, in the interest of completing the NEPA review, EPA has decided in this ROD to resolve the siting of a primary treatment plant as well. The decision is the All Primary Deer Island alternative.

## TABLE I

## LIST OF TWENTY-TWO INITIAL OPTIONS STUDIED IN THE SDEIS

Secondary Treatment Alternatives

1a.1 Secondary Treatment at Deer Island, Headworks at Nut Island with separate North and South System Secondary Treatment Processes.

1a.2 Secondary Treatment at Deer Island, Headworks at Nut Island with combined North and South System Secondary Treatment Processes.

1b.1 Secondary Treatment at Deer Island, Primary Treatment at Nut Island for South system, separate North and South System Secondary Treatment Processes.

1b.2 Secondary Treatment at Deer Island, Primary Treatment at Nut Island for South System, combined North and South System Secondary Treatment Processes.

1c Secondary Treatment at Deer Island for North System, Secondary Treatment at Nut Island for South System.

2a.1 Secondary Treatment at Deer Island for North System, Secondary Treatment at Long Island for South System, Headworks at Nut Island.

2a.2 Secondary Treatment at Deer Island for North System, Secondary Treatment at Long Island for South System, Primary Treatment at Nut Island.

2b.1 Headworks at Deer Island for North System, Headworks at Nut Island for South System, Consolidated Secondary Treatment at Long Island.

2b.2 Primary Treatment at Deer Island for North System, Primary at Nut Island, Consolidated Secondary Treatment at Long Island.

2b.3 Headworks at Nut Island, Primary Treatment at Deer Island for North System, Consolidated Secondary Treatment at Long Island.

3a Headworks at Deer and Nut Islands, Consolidated Secondary Treatment at Lovell's Island.

3b Headworks at Deer and Nut Islands, Consolidated Secondary Treatment at a new man-made island.

Primary Treatment Alternatives

4a.1 Primary Treatment of All System at Deer Island, Headworks at Nut Island. Local Outfalls.

4a.2 Primary Treatment of All System at Deer Island, Headworks at Nut Island, Deep Ocean Outfalls.

4b.1 Primary Treatment at Deer Island for North System, Primary Treatment at Nut Island for South System, Local Outfalls.

4b.2 Primary Treatment at Deer Island for North System, Primary Treatment at Nut Island for South System, Deep Ocean Outfalls.

5a.1 Primary Treatment at Deer Island for North System, Primary Treatment at Long Island for South System, Headworks at Nut Island. Local Outfalls.

5a.2 Primary Treatment at Deer Island for North System, Primary Treatment at Long Island for South System, Headworks at Nut Island. Deep-Ocean Outfalls.

5b.1 Headworks at Deer and Nut Islands, Consolidated Primary Treatment at Long Island. Local Outfalls.

5b.2 Headworks at Deer and Nut Islands, Consolidated Primary Treatment at Long Island. Deep-Ocean Outfalls.

Satellite options 1&2 - Satellite facilities for South System with discharge to Charles and Neponset Rivers. Satellite facilities for South System with wetlands discharge.

In screening the initial alternatives, it became clear that no alternative was without some potentially adverse impacts. Furthermore, no alternative satisfied all of the criteria used in the analysis. Considering the size and complexity of the project, virtually all alternatives were considered to have at least one or more drawbacks that limited their acceptability to some affected group(s).

The initial screening process concluded that of the twenty-two alternatives studied, four secondary treatment options and four primary options conformed to these criteria and warranted further investigation and more detailed study. These alternatives reflected different approaches to the siting requirements of the MDC system. The impacts of these options also varied in their respective advantages and disadvantages. The eight alternatives are identified below according to their abbreviated names used in the EIS. (Parenthetical references in Table I refer to the nomenclature used in the initial screening process.)

a. Secondary Treatment (Harbor Entrance Outfall) Alternatives:

1. All Secondary Deer Island (1a.2)

2. Split Secondary Deer Island and Nut Island (1b.2)

3. All Secondary Long Island (2b.1)

4. Split Secondary Deer Island and Long Island (2b.3)

b. Primary Treatment (Nine Mile Outfall) Alternatives:

1. All Primary Deer Island (4a.2)

2. Split Primary Deer Island and Nut Island (4b.2)

3. All Primary Long Island (5b.2)*

4. Split Primary Deer Island and Long Island (5a.2)

A detailed assessment of the impacts of these alternatives was provided in the SDEIS. Figure I shows the eight alternatives with their respective facilities and harbor locations.

During the further preparation of the SDEIS, relevant Massachusetts agencies and the EPA agreed that it was necessary to refine the decision process because of the complexity of the siting decision and the great number and variety of factors which must be taken into account by decision-makers. The first step was to re-analyze the various arguments and considerations that had been brought to bear on this controversial siting decision by all concerned parties in order to determine their disparate objectives. These objectives were used to develop a more precise set of decision criteria against which the remaining alternatives were to be evaluated. It was the goal of the SDEIS to make the list short, yet inclusive of all concerns that had been raised. Six decision criteria were identified. Each alternative was to be evaluated to determine the extent to which it:

1. is consistent with and, if possible, promotes the fulfillment of the promise of Boston Harbor. (Harbor Vision)

2. can be implemented in a timely and predictable manner. (Implementability)

3. minimizes the adverse impacts of the facility on neighbors, taking into consideration existing conditions, facility siting impacts and mitigation measures. (Effects on Neighbors)

4. minimizes the impacts of the facilities on natural and cultural resources. (Impact on Cultural and Natural Resources)

5. can be built and operated at a reasonable cost. (Cost)

6. maximizes the reliability of the entire treatment system. (Reliability)

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* Though the SDEIS/EIR suggested that one alternative, All Primary Long, should also be screened out and not receive further active consideration, the SDEIS/EIR and the FEIS contained a full evaluation of All Primary Long. EPA considers that all eight alternatives received an equal level of analysis.

Finally, EPA and the Commonwealth developed a comprehensive program of mandatory measures applicable to all alternatives: barging of materials, busing of workers, and noise and odor control.

Thus, in the SDEIS/EIR, EPA and the Commonwealth had narrowed the options remaining for secondary or primary treatment from twenty-two to eight alternatives, but had not arrived at a statement of two preferred alternatives, one for secondary treatment and one for primary treatment. The most important factor leading to this outcome was a desire on the part of both EPA and the Commonwealth to encourage public scrutiny and obtain formal public comment on the results of initial screening process, the large amount of new data, the new decision criteria and the proposed mandatory mitigation before proceeding to suggest two preferred alternatives.

After the close of the SDEIS/EIR public comment period, in light of the high degree of public acceptance, EPA decided to retain criteria as a way to impose order on a mass of detail in this especially complex review, and to focus on those impacts which are relevant to the choice of a site. EPA also reviewed all the public comments submitted to identify both those criteria-relevant issues which needed futher analysis prior to selection of a preferred alternative and those other issues which related to the overall project or were otherwise not criteria-relevant, but which were appropriate for inclusion in the FEIS or the FEIR. EPA performed additional analyses on potentially site-relevent topics.

EPA and the MWRA agreed that it was appropriate for each to pursue an independent decision-making process under their respective statuatory mandates but to do so in parallel and with a high degree of coordination. Accordingly, to ensure that both agencies shared a common data base, as either agency identified data needs or developed information, it was shared with the other by exchange of technical memoranda and through technical presentations at meetings with EPA's Technical Advisory Group or with the MWRA's Board of Directors or staff.

EPA systematically reviewed its entire data base using the decision criteria and evaluated each piece of data in terms of one or more of the appropriate decision criteria. EPA felt that each decision criterion was legitimate and was confident that sufficient objective data existed to permit a reasoned judgement as to the acceptability of the alternative sites.

## Mandatory Mitigation Measures

Upon the completion of the review of each decision criterion, the assumed level of mandatory mitigation as set forth in the SDEIS/EIR was either confirmed or, if appropriate, modified as the result of further technical information. EPA found that the most critical need for mitigation was to reduce impact on neighbors. EPA applied a set of specific mandatory mitigation measures to all alternative sites except as noted below. The mandatory mitigation measures can be summarized as follows:

- o Barging of bulk materials to and from the site to reduce the amount of trucking through affected communities during construction;

- o Use of a roll-on/roll-off barge loading facility at the site and at an onshore transfer station to accommodate heavy trucking;

- o Busing and ferrying of construction workers to reduce commuter traffic in affected communities during the construction period;

- o Use of "maximum feasible degree" of odor control and investigation of state-of-the-art odor control technology;

- o A ban on the use of liquid chlorine at Deer Island unless there is "clear and convincing" need for it and proof that it can be handled without unnecessary risk to neighbors, including the prison workers and inmates;

- o Implementation of noise control measures during construction, including the excavation of the Deer Island drumlin from the south side so that the remaining mass of the drumlin acts as a shield, and construction of a sound barrier at the Deer Island prison.

- o Prohibition against trucking liquid chlorine to Deer Island as soon as piers and staging areas are available to commence over-water transport;

- o Exploration of alternatives to the use of liquid chlorine at the treatment plant and at the associated headworks;

- o Sampling of volatile organic compounds downwind from the existing primary plants at Deer and Nut Islands, exploration of technologies to control these compounds and installation of appropriate controls if necessry;

- o Exploration of alternative treatment processes that might be less space demanding, less costly, or more reliable than secondary treatment based on the activated sludge process;

- o Exploration of the feasibility of developing recreational uses of the site along with the treatment plant;

- o Control of dust, erosion and sedimentation.

For a detailed statement of the mandatory mitigation measures, see pages 52-55 of the FEIS Volume I. Each of these mitigating efforts will be the subject of detailed study by the MWRA as further facilities planning explores these ways of achieving acceptable levels of impact. EPA, after appropriate environmental review, is prepared to modify these mitigation measures if equally effective protection can be achieved by other methods.

In the judgement of EPA, these stringent mandatory mitigation measures include all practicable means which are necessary and appropriate to avoid or minimize environmental harm from the alternative selected. EPA acknowledges that in some cases its mitigation package differs from the mitigation commitments described in the MWRA's FEIR and its findings under Section 61 of MEPA. EPA is confident, however, that its mandatory mitigation measures would result in an extraordinary degree of mitigation which would effectively minimize environmental harm.

Final Analysis*

During the final analysis, it became clear that three of the decision criteria, through theoretically important, no longer played site-distinguishing roles.

1. On "Cost," a more detailed analysis revealed that the costs of the four alternatives were so close that EPA decided to regard this decision criterion as having neutral effect.

2. On "Reliability," each of the sites permitted treatment plants of equal reliability.

3. On "Impact on Cultural and Natural Resources," though this decision criterion included federally protected resources (wetlands, barrier beaches, recognized historical and archeological sites, etc.), the impact of plants on either Deer or Long Island would be essentially equal and acceptable. On Nut Island, however, the Split Secondary Deer-Nut Alternative would involve the serious impacts of filling of tidal areas (unless homes were taken) and this was taken into account in the final decision.

Thus, "Effects on Neighbors," "Harbor Vision," and "Implementability" remained as the principal decision criteria for EPA. EPA felt each of these three criteria represented protection of important public values of substantial weight and each will be discussed below:

1. With respect to the "Effects on Neighbors" decision criterion, should the "no prison" variation of the All Secondary Deer Island alternative be implemented, EPA concluded that a treatment plant at either Deer Island or Long Island would have acceptable and essentially equal impacts on its neighbors, with the mandatory mitigation measures in place. However, if the prison were to remain on Deer Island, EPA concluded

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* In the following discussion it is important to note that, in the SDEIS/EIR, EPA and the Commonwealth concluded that under both Long Island alternatives, the Long Island hospital must be relocated off-island in order to avoid unacceptable impacts to "Effects on Neighbors," "Harbor Vision," and "Cultural and Natural Resources." EPA believes this conclusion remains valid.

that a plant site on Deer Island would have a greater effect on its neighbors than a site on Long Island, but these impacts as mitigated were acceptable. EPA felt that removal of the prison was desirable but not mandatory. EPA also concluded that the mandatory mitigation reduced the impacts so substantially that the plant could be constructed without unacceptable impact despite the presence of the airport and the prison.

The Split Secondary Deer-Long alternative would involve major construction activity of approximately the same perceived effect on the neighbors of each island as if the entire plant were being constructed there. Though those effects were found to be acceptable, it was felt to be unwise to impact two sets of neighbors unless there would be some benefit to another decision criterion; there was not.

Split Secondary Deer-Nut imposed severe burdens on its immediate neighbors on Hough's Neck without any corresponding benefit to Deer Island and Point Shirely. It was found to be environmentally unacceptable.

2. Considering only the "Harbor Vision" decision criterion, EPA concluded that though all four alternatives were acceptable, the All Secondary Deer alternative was preferred under "Harbor Vision". EPA believes that Deer Island's size, topography and setting give it acceptable long-term potential for rehabilitation as a park resource. However, because of Long Island's current potential as a major island park, EPA did conclude that while both All Secondary Deer and All Secondary Long satisfied the Harbor Vision decision criteria, All Secondary Deer satisfied it better.

Less acceptable were the other two alternatives. Though Split Secondary Deer-Long preserved significant potential recreation space at each island, EPA agreed with the Commonwealth that an entire island as park was preferable. Split Secondary Deer-Nut committed Nut Island to wastewater treatment without any corresponding benefit at Deer Island; though Nut Island has not been a major part of a harbor park plan, it could provide locally important open space.

3. Considering only the "Implementability" decision criterion, the following issues were of principal importance: permits and licenses, and the attitudes of the City of Boston and agencies and legislature of the Commonwealth. Even prior to the July 10, 1985, vote of the MWRA selecting All Secondary Deer Island as its tentative preferred alternative, EPA had concluded that the "Implementability" decision criterion pointed to All Secondary Deer with or without the prison because the principal remaining alternative, All Secondary Long (without the hospital), faced significant opposition. However, EPA was concerned that Deer Island prison removal was uncertain.

The July 10, 1985, and February, 1986 votes, and the MEPA Sec. 61 Findings of the MWRA, the proposing agency, which has the statutory authority to build the treatment plant and which controls much of Deer Island, confirmed EPA's conclusion that the All Secondary Deer alternative was clearly more implementable than any of the other alternatives.

The Governor's continued support of the MWRA, his renewed commitment to facilitate

relocation of the prison, and his new offer to identify a new prison site by May, 1986, further supports this result. Other officials have reiterated their support for prison removal if Deer Island is to be the site. As stated by the Secretary of Environmental Affairs in his Certificate on the FEIR, Janury 21, 1986:

> "...[T]hrough the joint struggle of all branches of government, the courts, the press, and the public, important milestones have now been passed - the creation of the Authority and public consensus on siting. A momentum has now built up, which I consider so powerful that the cleanup cannot and will not be stopped. The joint will of Mayor Flynn, Governor Dukakis, the General Court and our citizens is so strong that I am convinced the difficulties of prison relocation can be overcome..." (emphasis added)

EPA agrees with the MWRA that the reinforced support of relevant public officials for Deer Island prison removal and the continued opposition to Long Island Hospital removal makes prison removal "far more feasible" than hospital removal.

Furthermore, even if the prison were to remain, EPA notes the continued strong opposition of the city and state officials who control the future of Long Island to any use of Long Island as a treatment plant and notes their reiterated support for a Long Island park and for a continued role for the Long Island Hospital and Homeless Shelter.

Therefore, EPA confirms its previous judgement that All Secondary Deer Island (even if the prison were to remain) is more implementable than either of the other two environmentally acceptable alternatives: All Secondary Long and Split Secondary Deer-Long (both without the hospital).

In summary, with mandatory mitigation,

1. EPA found Split Deer-Nut to be environmentally unacceptable because of its severe impact on its "Neighbors" at Nut Island and on "Natural Resources," and strong barriers to "Implementability."

2. EPA found Split Deer-Long (without the hospital) to be environmentally acceptable; but EPA also found it to be undesirable because it spreads impacts on "Neighbors" and "Harbor Vision" to two islands without any benefit deemed valuable to a decision criterion. It also was unlikely to be "Implemented."

3. EPA found both All Secondary Long (without the hospital) and All Secondary Deer to have an acceptable impact on "Neighbors" and "Harbor Vision."
   a. "Neighbors." With mitigation, the impact of a Deer Island plant on its "Neighbors" is either equal to (without the prison) or worse than (with the prison) a Long Island plant.

b. "Harbor Vision". The impact of a Deer Island plant on the public benefits from and uses of Boston Harbor causes somewhat less harm than a Long Island plant.

c. "Implementability". Between these two acceptable and closely balanced alternatives, building a treatment plant on Deer Island (with or without the prison) is clearly more "Implementable" than building a Long Island Plant.

EPA's decision based on the foregoing analysis is that its preferred alternative is All Secondary Deer with mandatory mitigation. The FEIS contains more information on the decision process.

## IV. IMPLEMENTATION, MONITORING, ENFORCEMENT OF MITIGATION MEASURES

Applicable regulations require EPA, in this ROD, to adopt and summarize an implementation, monitoring and enforcement program for its mitigation measures.

EPA's first implementation, monitoring and enforcement mechanism will be through the construction grants program. Section 201(g) of the Clean Water Act authorizes the Administrator to grant financial assistance to municipalities for the construction of municipal wastewater treatment plants. Section 511(c) of the Act states that the award of a construction grant may be considered a major federal action significantly affecting the quality of the human environment, subject to the requirements of NEPA. These statutes give EPA the authority to enforce the mandatory measures through the federal construction grants program. The mandatory mitigation measures for the selected site at Deer Island will be made necessary conditions of any Federal construction grants awarded to the MWRA during the Step 3 Construction Phase of this project.

EPA has determined, pursuant to Section IV B 7 of the 1984 Construction Grants Delegation Agreement and 40 CFR Section 3015(c), that an overriding federal interest exists in this project, in particular in regard to the implementation of the mandatory mitigation program specified in the FEIS. In order to ensure that all mandatory mitigation measures are implemented through the construction grants program, the agency will play a direct role in oversight of facilities planning, design and construction of the wastewater treatment plant including piers, outfalls and pipelines/tunnels. The specific role that EPA plans to play will be at least as follows:

- o review all sections of all the facilities plans to ensure compliance with the mandatory mitigation program as set forth in FEIS Volume I, p.53-55.

- o coordinate with the Massachusetts Department of Environmental Quality Engineering (DEQE), Division of Water Pollution Control in reviewing the plan of study for the facilities plans.

- o participate in any technical and citizen advisory committees as part of the public participation program for the facilities plan.

- o participate in the review of the draft products of the facilities plans, particularly the development of the mandatory mitigation measures.

- o EPA will review at least the specifics of the proposed odor control program, noise control program and possible volatile organic compound emissions control program to ensure that MWRA is achieving effective impact reductions required by this ROD. On the issue of liquid chlorine use, EPA will ensure in its review of the facilities plan that MWRA has undertaken a thorough disinfectant alternatives analysis. On the issue of busing, ferrying and barging, EPA will monitor the development of the facilities planning investigations to ensure that MWRA establishes the required programs to mitigate transportation impacts.

- o coordinate with DEQE for joint review and approval of the final facilities plans. The facilities plans will be approved only upon successful development of the mitigation program as outlined in the FEIS.

- o EPA will request the Army Corps of Engineers, during construction, to make periodic onsite reviews to ensure that the project is being managed properly, is on schedule, and is being constructed in accordance with approved construction drawings and specifications including mitigation measures and change orders.

In order to facilitate a high degree of review oversight by EPA, the agency intends to enter into an agreement with the DEQE Division of Water Pollution Control and MWRA to outline further details of EPA's oversight.

In addition to EPA oversight and participation in further facilities planning, EPA intends to assume primary responsibility for NEPA review by the preparation of any environmental assessments or supplemental EIS's determined to be necessary in connection with these activities. EPA and the Army Corps of Engineers plan to enter into a Memorandum of Understanding in order to minimize delays in any environmental reviews involving both agencies.

Second, the MWRA is under federal court order to initiate facilities plans for the shore-side piers and staging areas, on-site piers and staging areas, outfalls and tunnels or piplines. The MEPA unit of the Executive Office of Environmental Affairs has made the determination that EIR's will be prepared on these facilities plans. In addition, the facilities plans will include EID's which provide environmental evaluations of the final facilities plan components. EPA will conduct an independent environmental review, under NEPA, of these facilities plans, except for those aspects of the wastewater treatment plant covered by this EIS.

Third, in the unlikely event that federal funding for this project were to be totally unavailable due to the termination of the Construction Grants Program, this project will require other federal actions which bring it within NEPA. These include the transfer of surplus federal lands by the General Services Administration (GSA); permit actions by the Corps of Engineers for the construction of piers and the disposal of dredged material or fill; and possible permit actions by EPA for the ocean disposal of fill. Each of these actions triggers independent opportunities to implement and enforce the mitigation program. For example, GSA intends to dispose of the surplus property in accordance with the FEIS and has committed to incorporate the mandatory mitigation measures into its own Record of Decision as appropriate.

Fourth, this project is now the subject of a federal court action (United States of America v. Metropolitan District Commission, et al., Civil Action No. 85-0489 D.C. MA and a related case.) In the event of the cessation of the construction grants program, EPA will also consider seeking an order of the federal court mandating that the mitigation program laid out in the FEIS be implemented.

Fifth, it should also be noted that the MWRA has committed to the Commonwealth that it will undertake a set of mitigation measures which are, with the exception of prison removal, substantively equivalent to those required by EPA. These are contained in the Section 61 Findings of the MWRA to the Secretary of Environmental Affairs under the MEPA.

[See also Section 3.2.11 (FINAL SELECTION) of this Volume.]

FURTHER ENVIRONMENTAL REVIEW UNDER NEPA

EPA expects that further environmental review under NEPA relating to the cleanup of Boston Harbor will include appropriate study of the following phases of the process, including cumulative impacts:

1. Long-term residuals management, including the processing, transport and ultimate disposal of sludge. Scoping for this EIS has already commenced.

2. The construction of pier(s) and staging area(s) at the treatment plant site and on shore to allow for barging of bulk construction materials, equipment, and work crews during construction, and possible transport of sludge. In the event that an existing pier cannot be located on the mainland, an additional pier or piers and staging area(s) would need to be constructed there.

3. The construction of an under-harbor tunnel or pipeline to transport wastewater to the treatment plant.

4. The water quality and construction impacts of an outfall pipe or pipes through which effluent will be discharged.

5. The possible disposal of earthen or dredge materials which might need to be removed from the site of the secondary treatment plant prior to construction.

6. The possible transport, handling, storage, and use of chlorine at the secondary treatment plant, depending upon the outcome of studies by MWRA regarding the environmental acceptability of its transport, handling, storage and use.

7. Combined sewer overflow projects.

CONCLUSION

EPA has engaged in a decision process which gathers technical information, exposed it to extensive public scrutiny, developed very stringent mitigation measures, and evaluated the alternatives in terms of disclosed decision criteria. EPA believes this open process has arrived at a fair and reasonable conclusion that the upgraded treatment plant, considered singly or in combination with other conditions, will be constructed and operated with acceptable environmental results.

## 3.3 RELATED PROJECTS

### 3.3.1 PROJECTS

Although the Secondary Treatment Facilities Plan is the beginning of the key project in the Boston Harbor Cleanup Program, there is a long list of projects that are being planned, designed or are under construction to upgrade and expand the MWRA's wastewater collection and treatment capabilities. These projects are grouped into the following programs:

Treatment Plant Upgrade
- Nut Island Immediate Upgrade
- Deer Island Fast Track Improvementss

Interim Residuals Management
- Interim Sludge Processing and Disposal
- Interim Scum Management

Long-Term Residuals Management
Water Transportation Facilities
Combined Sewer Overflows
Harbor Research and Monitoring

In addition to the above wastewater programs, several waterworks projects have either a direct or an indirect bearing on the secondary treatment facilities planning. MWRA has also initiated several projects to strengthen its ability to direct and manage its extensive capital program and its extensive day-to-day operational responsibilities. The projects designed to strengthen

MWRA's institutional capability are described in Volume VII, Institutional Considerations. The related wastewater programs are described briefly in the following paragraphs.

### 3.3.2 INDUSTRIAL WASTE PROGRAM

In February of 1973, MWRA's Industrial Waste Program began to acquire data on all industries within the 43 cities and towns which comprise the sewerage district. This program has become the means whereby the Authority enforces Federal, State and MWRA regulations which govern the discharge of wastewater to the sewer system. The goals of the enforcement strategy are to decrease and control pollution loads to the treatment works; increase safety for maintenance and operational personnel; reduce illegal waste discharges such as extraneous water and septage from non-member municipalities; and prosecute for willful damage or vandalism.

The Industrial Waste Program, which was approved by the EPA in July of 1982, is being implemented in four phases: Inspections, Monitoring, Permitting and Enforcement.

#### Inspection Activities

The inspection program includes on-site inspection of all indusries in the district. It requires a discussion period with appropriate plant personnel to ascertain the type of activity being performed at the facility, the raw materials used, products and services produced, and the particular processes and unit operations employed. A tour of the facility is also conducted to verify the information received. Industries suspected of discharging a questionable waste are required to submit the results of laboratory analyses, performed on representative samples of the process waste by an independent laboratory, for review and evaluation by the Authority. The results of analyses, along with other pertinent information (permit application, inspection reports) on the industry, are used to determine whether or not the wastes are in compliance with the MWRA's Rules and Regulations. A permit application must be completed by all users discharging industrial wastes.

An intensified Industrial Inspection Program has commenced as a result of the increase in staff and resources. In Fiscal Year 1987, approximately 425 industrial inspections were conducted.

#### Septage Disposal Inspection Program

The Septage Disposal Inspection Program is basically divided into two activities: first is the oversight of the septage control activities of the member municipalities with septage receiving locations; and second is surveillance of each septage receiving location to determine compliance with MWRA Rules and Regulations and to identify any illegal septage dumping.

Each member municipality which operates or has designated a septage receiving station is responsible for the control and monitoring of all activities at the septage receiving location. The Water Quality Section evaluates control procedures at each septage receiving location for the purpose of determining the municipality's ability to control the dumping of septage from

non-member communities, to prevent the discharge of industrial or toxic wastes, and to verify the origin of all septage received at each septage receiving location.

In some instances the possibility of illegal or uncontrolled dumping at certain septage receiving locations is suspected. In response to these instances, surveillance of the septage receiving site is conducted in order to document septage disposal, and possibly identify illegal dumping activities requiring enforcement of dumping restrictions.

Identification of I/I and Surcharging During Routine Investigations

In addition to identifying sources of toxic discharges to the sanitary sewer system, investigations at industrial facilities often identify the illegal discharge of "clean" water, also known as inflow. During these industrial investigations the most common form of inflow uncovered is non-contact, uncontaminated cooling water and non-contact, uncontaminated industrial process water.

In addition to identifying these and other sources of inflow, inspection personnel often identify excessive use of water and make recommendations to limit water use. These recommendations serve to reduce the flow in the already overloaded sewer system, which helps to minimize surcharging.

Monitoring Activities

The Monitoring Section of the Water Quality Department continually participates in a variety of activities, the most significant being monitoring for the Industrial Waste Pretreatment Program. More specialized areas of monitoring include sampling at the Treatment Plants, fulfilling NPDES Permit monitoring requirements, soil sampling, beach sampling, and verification of discharges and connections. Monitoring activities during Fiscal Year 1987 numbered 565, compared to 200 in Fiscal Year 1986.

Collection of industrial waste samples from industries discharging into the Authority's Sewer System yields a profile of industrial wastes currently entering the system and provides the basis for enforcement to eliminate unacceptable concentrations of toxic and potentially harmful substances. The samples collected are forwarded to a laboratory for analysis, where strict Quality Assurance/Quality Control procedures are employed. Analytical results from this monitoring, in conjunction with information derived from inspecting and permitting activities, assist in determining the acceptability of the discharge and whether enforcement action is warranted.

The Monitoring Team has been involved in site assessment and the implementation of the monitoring program to fulfill the NPDES Permit requirements. The permit requires monitoring at Deer and Nut Island Treatment Plants and at three Combined Sewer Overflow (CSO) facilities (Cottage Farm Chlorination and Detention Station, Charles River Estuary CSO Treatment Facility, Somerville Marginal CSO Pretreatment Facility). At the treatment plants, samples are taken monthly for parameters not monitored daily by the plants, such as organics, metals and cyanide.

Beach sampling has been frequently requested in response to reports of odor problems and unidentified growths or discharges into the harbor.

Other monitoring activities include sampling soil or sludge to determine the degree of contamination to assist in proper disposal decisions, verification of discharges and connections via dye tests and researching sewer line maps, groundwater sampling, and sampling at construction or cleanup sites before discharge to the sanitary sewer system.

Municipal Permits/Sewer Use Discharge Permits

Sewer Use Discharge Permits are issued to each sewer user discharging industrial wastes located in the Authority Sewer District regardless of size, type or volume of discharge. For permitting purposes, the Sewerage Division has classified users into four categories according to the nature of their wastes. The categories are as follows:

1. Industries requiring pretreatment.
2. Industries having some toxic discharges but at concentrations which do not require pretreatment.
3. Industres which have non-toxic discharge in addition to sanitary flow.
4. Dry industries or industries with sanitary flow only.

Sewer Use Discharge Permits are revised as new information is received. At present, much of the activity involving permits is due to revisions and renewals, which are done on a daily basis.

Compliance and Enforcement

The Authority has been extremely successful in working with its Sewer Users in a cooperative spirit to eliminate existing or potential discharge problems, since the inception of the Industrial Waste Program. Over the years, thousands of industries and other sewer users have been inspected, monitored and issued permits. Through the inspection, monitoring and permit phases of the Water Quality Department's Industrial Waste Program, many of these industries were found to be in violation of acceptable discharge practices. Any continued violations of permit conditions or Sewer Use Rules and Regulations will result in enforcement actions to assure compliance with acceptable discharge practices. New Sewer Use Rules and Regulations promulgated May 1, 1987 have broadened the scope of MWRA enforcement powers, including rights to:

1. Issue an order to cease and desist any such discharge violations;

2. Direct a User to submit a detailed schedule, subject to such modifications as the Authority deems necessary, setting forth actions to be taken to correct or prevent a violation;

3. Issue an implementation schedule ordering specific actions and a time schedule;

4. Revoke, modify or deny a permit issued to the User by the Authority;

5. Impose administrative penalties up to $10,000 per day of continued violation, and seek payment for damages to its system pursuant to 360 CMR 10.105 and 360 CMR 2.00;

6. Bring a civil or criminal action as provided by law;/ or

7. Take any other action available to it under federal, state or local law or regulation.

In cases where significant resistance is given to the Authority's discharge regulations, enforcement actions have been initiated. Enforcement actions to date range from informal meetings with the offending companies to legal actions taken through the Office of the Attorney General of the Commonwealth of Massachusetts. The results have been civil penalties ranging upward of $600,000 and agreements for judgements mandating adherence to strict compliance schedules.

The Authority's newly promulgated Administrative Penalty Regulations and Rules for Adjudicatory Proceedings will enable the Water Quality Department to be more effective in enforcement. The Authority is also establishing firmer policy and procedures which will be followed for the imposition of Civil Penalties in those future cases which require the assessment of fines.

### 3.3.3 TREATMENT PLANT UPGRADE PROGRAMS

Both the existing Deer Island and Nut Island Treatment Plants are being upgraded to extend the useful life of the installed facilities until the new treatment facilities can be constructed and placed into operation.

The Nut Island Immediate Upgrade Project began in January, 1983 and is expected to be completed in May, 1988. Eight projects costing approximately $12 million have been initiated to extend the useful life of the Nut Island Plant approximately ten years. Table 3.3.3-1 summarizes the eight immediate upgrade projects. Table 3.3.3-1 also describes other projects that are planned or underway to rehabilitate the existing treatment plant.

The Deer Island Treatment Plant Fast Track Improvementss Program consists of several projects to raise the operating efficiency of the existing plant to an acceptable level. The construction of these upgrading projects started in June, 1986 and is expected to be completed in March, 1990. The Deer Island Fast Track Improvements Program is summarized in Table 3.3.3-2. Other projects that are expected to improve the service life of the existing facilities on Deer Island are also described in Table 3.3.3-2. These rehabilitation projects also include upgrading the remote headworks facilities which function as an integral part of the Deer Island Treatment Facilities.

**TABLE 3.3.3-1**
**NUT ISLAND IMMEDIATE UPGRADE**

o Power

- Rebuilding of one engine generator
- Installation of 2000 kw transformer for purchased off-site power to the site

o Preliminary Treatment

- Addition of influent flow meter (sonic type) on the High Level Sewer
- Installation of new ventilation system, odor control equipment, and explosion-proof electrical components to the grit facility
- Removal of comminutors downstream from the grit chambers
- Rebuilding of the effluent channels from the grit tanks
- Replacement of air header to the preaeration basins
- Rebuilding of one preaeration blower motor

o Primary Sedimentation

- Structural rebuilding of tanks and repairing of leaks
- Levelling of tank floors
- Replacement of all weirs
- Replacement of sludge collection equipment

o Digesters

- Replacement of outside sludge piping from the primary sludge pumps to the anaerobic digesters
- Digester roof rehabilitation

o Outfalls

- Installation of an automated sluice gate at the outfall
- Cleaning of the two main outfalls

o Electrical Distribution Substation Replacement

o Sewerage Pump Switchgear Replacement

TABLE 3.3.3-2

DEER ISLAND TREATMENT
FACILITY
FAST TRACK IMPROVEMENTS

- o Pump Station and Power Station Improvements
  - 5 new 90 mgd influent sewage pumps
  - 4 new 2000 Hp electric motors
  - New graphic control center to monitor sewage flow
  - New cooling water system for engines
  - New pumps for process water building
  - New heating system process water building
  - 2 new 6000 kw dual fuel, engine/generator sets
  - New switch gear/electrical distribution center
  - New fuel storage system for engines
- o Rehabilitation of Digesters
  - 4 new floating roofs
  - New internal digester piping
  - New gas meters at each digester
  - New waste gas burners with meters
  - 6 new spiral heat exchangers
  - 4 new sludge hot water pumps
  - 1 new boiler
  - Rehabilitation of 2 Ingersoll-Rand gas compressors
  - A new heating and ventilating system for both the sludge thickener and the digester complexes
  - A gas detection system for both complexes
- o Sludge Thickener Improvements
  - Remove existing tank mechanisms
  - Remove existing bridges, pumps and associated piping
  - Install new thickener mechanisms and bridges
  - Install new sludge transfer system, pumps and compressors
  - Install associated piping, electrical and control instrumentation
- o Primary Sedimentation Basins Improvements
  - New grit collection system
  - New grit classification building
  - New scum concentration building

- New chemical feed building
- Influent and effluent sampling stations
- 80 new motorized influent sluice gates and 80 stainless steel baffles
- New flow splitter plate, to equalize grit distribution
- Structural repairs to the sedimentation basins and bridges
- 48 new stainless steel aeration leaders and diffusers
- 3 new air compressors for the aeration channels

o Chlorine Rehabilitation

- 8 new evaporators
- 8 new chlorinators
- 2 new scale systems
- New HVAC system
- New roof
- New piping and distribution system for chlorine and process water

o Electrical Upgrade

- 4 new electrical distribution substations
- New conduit for substations
- New motor control centers throughout Deer Island

o Dual Fuel/Generator Overhaul

- Overhaul of 5 diesel enginers 1000 Hp
- Overhaul of 4-700 kw generators

o Deer Island Remote Headworks Improvements
(Columbus Park, Chelsea Creek and Ward Street)

- New grit collection and removal equipment for all 12 channels (four at each facility)
- New climber-type mechanical screens
- New HVAC equipment
- New odor control equipment
- Improvements to electrical systems
- Monorails, hoists and bridge cranes
- Hydraulic power units for sluice gates

o Winthrop Terminal Headworks Improvements

- Three climber-type mechanically cleaned bar screens
- Grit collection equipment

**Table 3.3.3-2** (cont'd)

- Three inlet sluice gate operators and hydraulic power system
- Overhaul six sewage pumps (4-16,000 gpm and 2-32,000 gpm)
- Six new drive motors and controls
- Screening discharge enclosure
- Two stair access/egress towers

### 3.3.4 INTERIM RESIDUALS MANAGEMENT PROGRAM

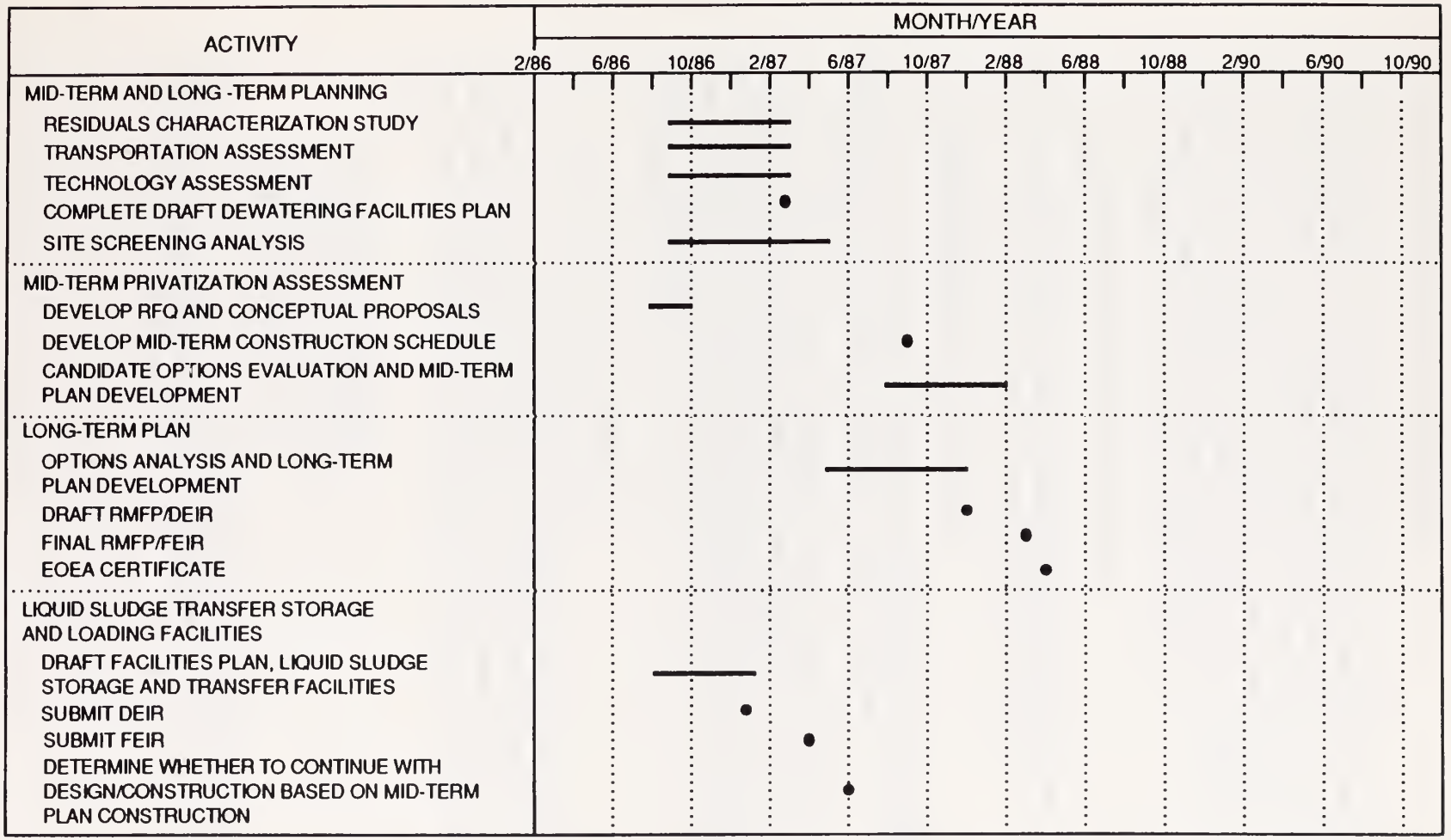
The Interim Residuals Management Program is intended to provide the facilities necessary to cease the discharge of sludge to the ocean by 1991. MWRA is presently soliciting proposals from private firms to provide land based disposal of sludge until the long term management facilities now being planned are constructed in 1995. The Interim Residuals Management Program includes sludge from both the Deer Island and the Nut Island Treatment Plants.

A second component of the Interim Residuals Management Plan is interim scum management. Scum is the floatable material that is skimmed from the surface of sedimentation facilities at both treatment plants. Scum is currently mixed with the sludge and discharged to the Harbor. Because these materials are the more obnoxious and visible discharge to the Harbor, the removal of these materials has been given the highest of priorities. For the interim period at Nut Island, scum screening, chemical conditioning and landfill disposal was selected as the recommended scum handling option. Design of these facilities was initiated in May, 1987. At Deer Island, the recommended plan for termination of scum discharges involves a one year demonstration project. This project includes chemical fixation of all Deer Island scum by a private contractor with storage on-island. Initiation of this period is anticipated in November, 1987. At the end of the one year demonstration, a decision will be made to build permanent facilities or to continue with a service contract.

A third component of the interim residuals management plan is a composting pilot plant. Composting stabilizes organic materials and destroys bacteria and viruses in sludge. Composted sludge has the potential for use as a soil supplement for production of turf grass, horticultural uses at green houses, use as a low-grade fertilizer or use as a landfill cover material. The pilot plant was initiated in 1984 and currently processes fifteen dry tons per day of sludge. The pilot plant serves the dual purpose of reducing the quantity of sludge discharged to the harbor and at the same time provides a compost product to test and develop a market for the material in the greater Boston area. The compost pilot also provides valuable information for the assessment of the viability of composting as a long-term residuals management option.

### 3.3.5 LONG-TERM RESIDUALS MANAGEMENT FACILITIES PLAN

The facilities planning for the long term management of residual solids is being conducted concurrently with this planning effort. The planning effort includes assessment of the quantity and quality of Deer Island and Nut Island sludge, survey of available sludge processing and transport technologies, selection of appropriate technologies, screening of potential disposal sites and selection of optimum facilities and sites. Design and construction will include both on-island and mainland facilities. The facilities planning is scheduled for completion in 1988. Figure 3.3.5-1 illustrates the general flow of planning activities for the residuals management facilities plan.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 3.3.5-1**
**RESIDUALS MANAGEMENT PROJECT SCHEDULE**

### 3.3.6 WATER TRANSPORTATION FACILITIES

The Water Transportation Program includes the construction of the piers and related facilities to move materials, workers and equipment to and from Deer Island for the construction of the new treatment facilities and at Nut Island to support construction of the new headworks facility. Facilities planning for both on-island and on-shore piers is essentially complete. On-island piers are now being designed. Construction of these essential facilities is expected to commence in March, 1988 and be completed in September, 1989. Construction of the on-shore piers is expected to start in September, 1988 and be completed in May, 1990. See Figure 3.3.6-1 for a schedule of water transportation facilities planning.

### 3.3.7 COMBINED SEWER OVERFLOW PROGRAM

MWRA is currently evaluating a means of abating pollution from combined sewer overflows. Figure 3.3.7-1 denotes the overall facilities planning for the CSO program.

### 3.3.8 HARBOR RESEARCH AND MONITORING

The ultimate goal of this project is the design and implementation of a plan for action directed towards cleaning up Boston Harbor and protecting the Harbor in the future.

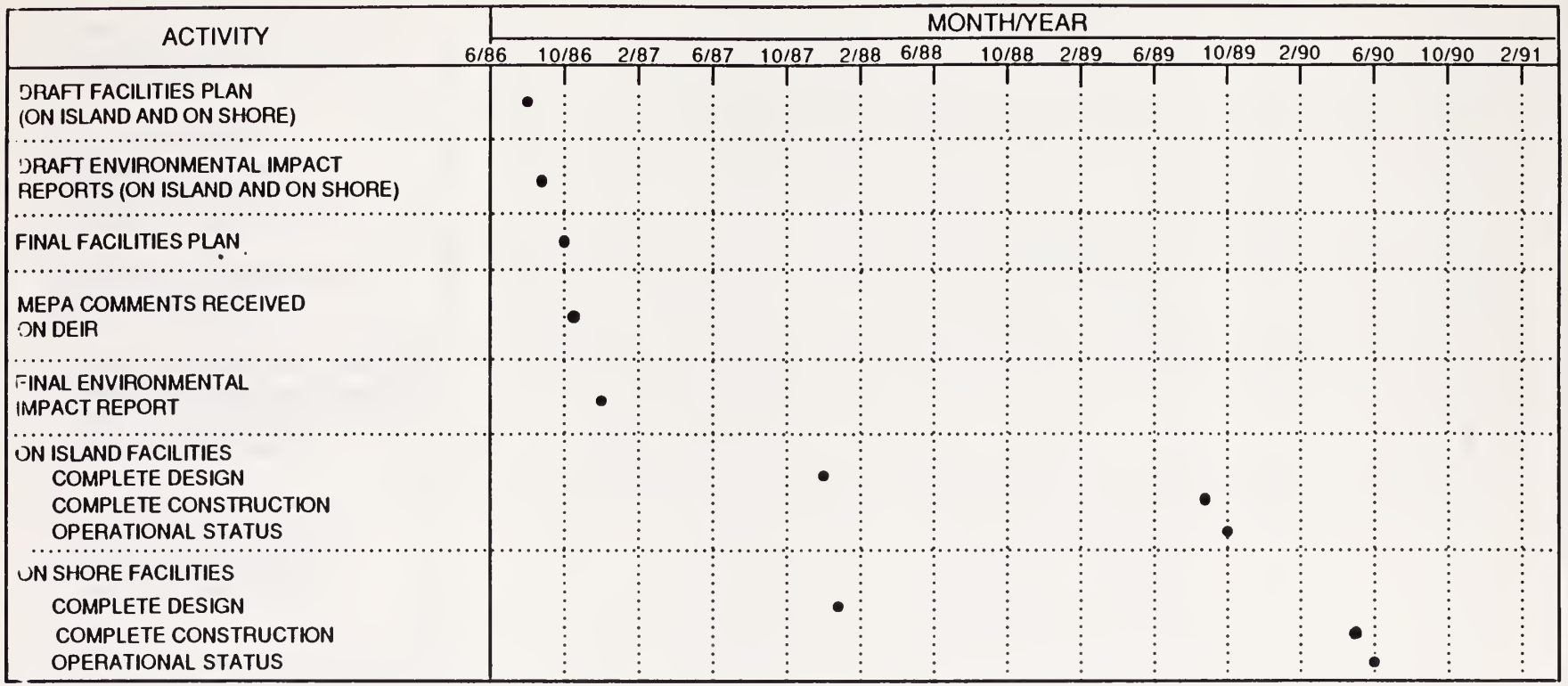
A Technical Advisory Group (TAG), established in 1986, produced a "Study Plan for Basinwide Management of the Boston Harbor/Massachusetts Bay Ecosystem". This plan defined the goals for research and monitoring in Boston Harbor and Massachusetts Bay that will be closely tied to management issues. The study plan further identified many issues facing environmental managers. Of these issues, five have been identified as high priority, requiring a well-focused scientific study.

### 3.3.9 WASTEWATER TRANSPORT PROGRAM

MWRA member communities discharge their wastewater through 1825 connections and 5400 miles of local sewers to 228 miles of MWRA sewers and 10 MWRA pump stations. In 1976, the EMMA study recommended approximately $1.7 billion in improvements to sewers through the year 2000. Since 1976, the sewer relief program has informally taken on a definition involving four major projects:

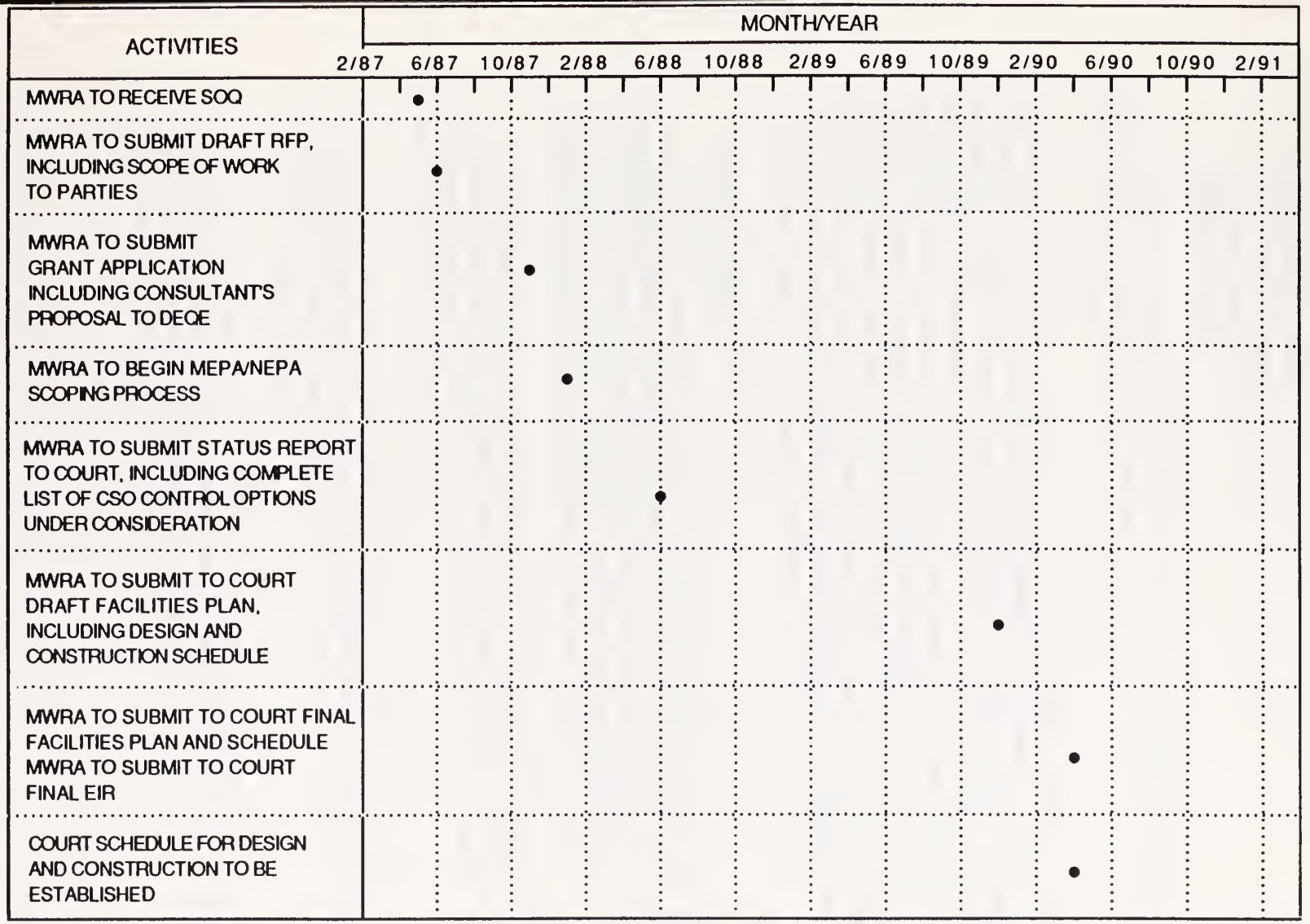
Braintree-Weymouth Relief Sewer
New Neponset Valley Relief Sewer
Framingham Extension Relief Sewer
Wellesley Extension Relief Sewer

Progress has been slow on the four major projects due to the complex and controversial nature of each project. The MWRA has, however, demonstrated success with the following projects either under construction or completed:




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 3.3.6-1**
**WATER TRANSPORTATION FACILITIES PROJECT SCHEDULE**


ACTIVITIES
MONTH/YEAR
2/87
6/87
10/87
2/88
6/88
10/88
2/89
6/89
10/89
2/90
6/90
10/90
2/91
MWRA TO RECEIVE SOQ
MWRA TO SUBMIT DRAFT RFP, INCLUDING SCOPE OF WORK TO PARTIES
MWRA TO SUBMIT GRANT APPLICATION INCLUDING CONSULTANT'S PROPOSAL TO DEQE
MWRA TO BEGIN MEPA/NEPA SCOPING PROCESS
MWRA TO SUBMIT STATUS REPORT TO COURT, INCLUDING COMPLETE LIST OF CSO CONTROL OPTIONS UNDER CONSIDERATION
MWRA TO SUBMIT TO COURT DRAFT FACILITIES PLAN, INCLUDING DESIGN AND CONSTRUCTION SCHEDULE
MWRA TO SUBMIT TO COURT FINAL FACILITIES PLAN AND SCHEDULE
MWRA TO SUBMIT TO COURT FINAL EIR
COURT SCHEDULE FOR DESIGN AND CONSTRUCTION TO BE ESTABLISHED

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 3.3.7-1**
**COMBINED SEWER OVERFLOWS PROJECT SCHEDULE**

Millbrook Valley Relief Sewer
Reading Pumping Station
Reading Extension Sewer
East Boston Pumping Station
Hingham Force Main

The Water Transport Program is moving forward, with the potential downstream impacts of the utmost concern. The Southern System Modeling Project, which is now underway, is the first major step in this process.

MWRA plans to participate in a joint public and private effort to establish a Harbor monitoring and research program. The program will conduct research that will report on existing conditions and measure incremental change as the residuals management program and treatment plant upgrading are implemented. The priority areas to be studied include: (1) sources and fate of contaminants; (2) effects of contaminants and the health of the living resources; (3) nutrient enrichment; (4) economic, legal, political and social science assessment and; (5) public health impact. The study of these areas requires both short term projects designed to answer particular questions and a monitoring program that will determine long term impacts of human activities on the marine ecosystem. The technical results produced by these studies should be used in multiple-use management endeavors conducted by several agencies.

## 3.4 PROJECT MILESTONES

Though pollution of Boston Harbor has been a matter of public concern since the late 1960's, awareness was heightened in December of 1982 when the City of Quincy filed a lawsuit against the Metropolitan District Commission and the Boston Water and Sewer Commission (BWSC). Quincy sought relief from the pollution of Quincy Bay, which it claimed was resulting from the discharges of untreated and partially treated sewage from Nut Island and Moon Island.

As a result of this suit and the recommendations of the court-appointed special master, a bill was filed to remove sewer responsibilities from the MDC and to place them in a financially and organizationally independent public authority. On December 19, 1984, the Massachusetts Water Resources Authority was created.

On the following day, the EPA announced its intention to take additional action to help secure a harbor cleanup and brought suit in federal court, requesting a set of deadlines for pollution control projects. Filed at the end of January, 1985, the suit named four defendants: the MDC, the MWRA the state and the BWSC.

As a result of this lawsuit, on May 8, 1986 the United States District Court of Massachusetts imposed "major milestones" as long-term target dates to assist facilities planners toward the completion of primary and secondary treatment facilities. These dates are as follows, with milestone dates relating to this facilities plan in bold type:

Design and Construction of Piers and Staging Areas and Facilities Planning

On-Island

| | |
|---|---|
| a. Complete Design | 12/87 |
| b. Bid Construction | 5/88 |
| c. Award Construction | 8/88 |
| d. Complete Construction | 9/89 |
| e. Attain Operational Status | 6/90 |

On-Shore

| | |
|---|---|
| a. Complete Design | 1/88 |
| b. Bid Construction | 6/88 |
| c. Award Construction | 9/88 |
| d. Complete Construction | 5/90 |
| e. Attain Operational Status | 6/90 |

**Facilities Planning**

| | |
|---|---|
| **a. Project Start** | **5/86** |
| **b. File ENF (s) (see appendix F of this volume)** | **6/86** |
| **c. Complete Draft Facilities Plan** | **9/87** |
| **d. Complete Draft EIR** | **11/87** |
| **e. Complete Final Facilities Plan** | **12/87** |
| **f. Complete FEIR** | **2/88** |
| **g. Complete Environmental Review** | **4/88** |
| **h. Accept Facilities Plan** | **5/88** |

Construction of Treatment Plant, Outfall, and Inter-Island Wastewater Conveyance System

| | |
|---|---|
| a. Initiate construction of new primary treatment facilities | 12/90 |
| b. Complete construction and commence operation of new primary treatment facilities | 7/95 |
| c. Initiate construction of outfall | 7/91 |
| d. Complete construction of outfall | 7/94 |
| e. Initiate construction of inter-island wastewater conveyance | 4/91 |
| f. Complete construction of inter-island wastewater conveyance | 12/94 |
| g. Initiate construction of secondary treatment facilities | during 1995 |
| h. Complete construction of secondary treatment facilities | during 1999 |

The 1986 Court order allows for the re-examination of these long-term target dates for the completion of this Facilities Plan.

# Section 4

# SECTION 4.0 BASIC PLANNING CRITERIA

## 4.1 PLANNING PERIOD

The planning period used in this facilities plan encompasses the period from now through the year 2020. This represents the first twenty years of operation of the secondary plant which has been stipulated by the federal court to be in operation not later than the end of 1999. The use of twenty-year planning periods is considered generally accepted practice in the engineering profession, and is required by facilities planning regulations issued by the U.S. Environmental Protection Agency (EPA).

## 4.2 SERVICE AREA

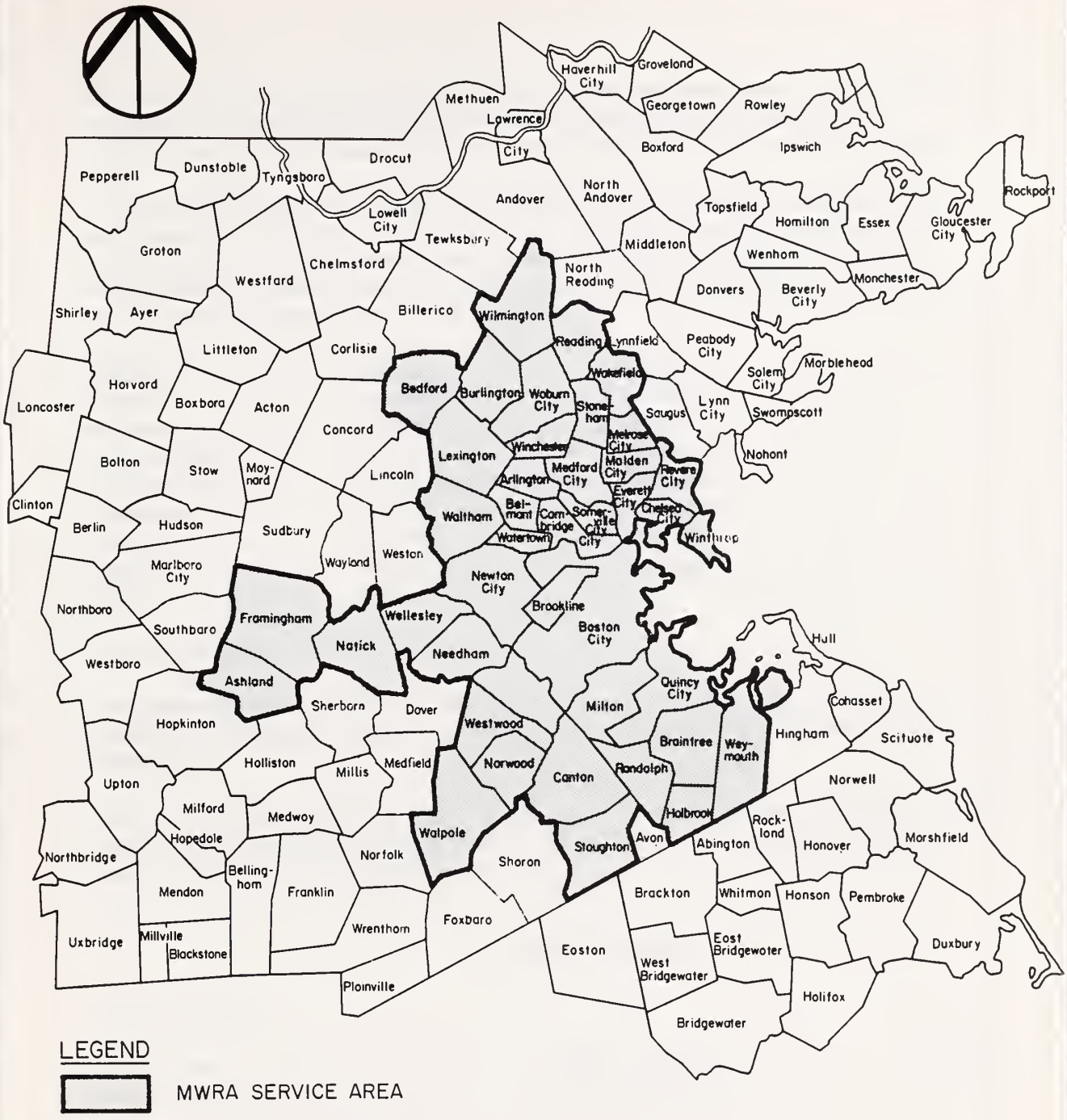
Under its enabling legislation, MWRA is charged with providing treatment to the wastewaters generated in 43 municipalities and special districts. The legislation permits permanent sewer service to other communities, but only after these communities have shown that no feasible alternatives exist, and after numerous regulatory and legislative approvals have been obtained.

Expansion of the service area, if it takes place, will occur at the boundaries of the existing service area. Figure 4.2-1 shows the existing service area, together with communities which are adjacent to the boundary of the area. Most of the communities abutting the Authority's service area are already served by a wastewater system. Any system expansion which might be considered would be on a very limited basis due to existing wastewater utilities on the perimeter of the MWRA service area. Therefore, in developing population and flow projections, the existing service area was used as a base.

Currently, MWRA owns and operates two wastewater treatment plants, one at Deer Island and the other at Nut Island, which handle wastes from the North and South Metropolitan Sewer Service Areas. Some communities in the service area are serviced by both plants. At present, the system provides preliminary and primary treatment, which consist of screening and grit removal, sedimentation, and chlorination. Both the treated effluent and concentrated, digested sludges are discharged into Boston Harbor.

The Nut Island Facility (servicing the South System) has been in operation since 1952 and presently serves the following twenty-one communities:

| | | |
|---|---|---|
| Ashland | Hingham (N. Sewer Dist.) | Quincy |
| Boston (portion) | Holbrook | Randolph |
| Braintree | Milton (portion) | Stoughton |
| Brookline (portion) | Natick | Walpole |
| Canton | Needham | Wellesley |
| Dedham | Newton (portion) | Westwood |
| Framingham | Norwood | Weymouth |




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 4.2-1**
**MWRA SERVICE AREA**

The Southern System encompasses an area of approximately 240 square miles and presently has a total population of approximately 750,000 and a contributing population of approximately 630,000. Five MWRA pumping stations are located throughout the South System contributing area.

The Deer Island Facility (servicing the North System) has been in operation since June 1968 and serves twenty-six communities. The area served by this treatment plant is approximately 170 square miles with a total population of approximately 1,300,000 and a contributing population of approximately 1,250,000. Six MWRA pumping stations are located throughout the North System contributing area. Member cities and towns include:

| | | |
|---|---|---|
| Arlington | Lexington | Stoneham |
| Bedford | Malden | Wakefield |
| Belmont | Medford | Waltham |
| Boston (portion) | Melrose | Watertown |
| Brookline (portion) | Milton (portion) | Wilmington |
| Burlington | Newton (portion) | Winchester |
| Cambridge | Reading | Winthrop |
| Chelsea | Revere | Woburn |
| Everett | Somerville | |

### 4.2.1 DATUM PLANES

The base elevation to be utilized in the facilities plan is the MDC Sewer Datum. This is compatible with the datum previously used for the existing Deer Island and Nut Island treatment facilities.

Various datum planes are used in the Boston area, most commonly Mean Sea Level Datum (USGS datum of 1929), Boston City Base, and the MDC Sewer Datum. The relationship of the various datums to the MDC Sewer Datum are shown below:

DATUM PLANES

| To Convert From | To | Add |
|---|---|---|
| USGS Datum | MDC Sewer Datum | 105.62 ft |
| Boston City Base | MDC Sewer Datum | 99.97 ft |

## 4.3 CRITERIA FOR PRELIMINARY EVALUATION OF UNIT PROCESSES

In order to screen the unit processes considered for wastewater treatment at the proposed Deer Island facilities, screening criteria were developed. Each unit process was evaluated on the basis of area requirements, experience, performance at large municipal wastewater treatment facilities, and relative capital and operating costs. Following these critical criteria, each unit process was then compared to a reference unit process that accomplishes the same function, using 14 additional criteria. The comparison considers the utilization of the unit process at Deer Island and may not necessarily represent the evaluation of other treatment facilities or a generic comparison of unit processes. The unit processes are examined in four function areas: preliminary treatment, primary treatment, secondary treatment, and disinfection. The reference processes for preliminary treatment are aerated grit chambers and catenary screens; for primary treatment, circular clarifiers; for secondary treatment, air activated sludge and circular secondary clarifiers; and for disinfection, the use of liquid chlorine.

### 4.3.1 SCREENING CRITERIA

The following paragraphs define each criterion and describe how the criterion was used to screen unit processes. Table 4.3.1-1 summarizes the evaluation criteria and ratings.

#### Area Requirements

Area requirements were estimated for each unit process by use of process sizing criteria. The criteria for each unit process are presented in the following sections. A plant average day flow of 500 mgd was utilized to determine the volume and/or surface area required. Since all unit processes require multiple units, the space between units was taken into account in the area requirements. However, the total area presented does not include area for support support facilities, roadways, or interprocess flow conveyance. Area requirements should be compared to unit processes accomplishing the same function. Unit processes requiring significantly more area than the reference unit process will likely be eliminated from further consideration since land area available at Deer Island is limited.

#### Municipal Wastewater Experience and Performance

The experience and performance of each unit process were evaluated at large municipal wastewater treatment facilities. Some of the information reviewed included the number of years of operation, size of facilities, history of operation and maintenance, problems encountered, ability to handle peak flows, and performance as measured by process effluent quality. If a unit process had not been demonstrated successfully at a large municipal wastewater treatment facility, it was not selected for detailed evaluation.

## TABLE 4.3.1-1

## SUMMARY OF EVALUATION CRITERIA FOR UNIT PROCESS EVALUATION

| Evaluation Criteria | Rating | | |
|---|---|---|---|
| Reliability | low | avg. | high |
| Flexibility | low | avg. | high |
| Constructibility | difficult | normal | - |
| Safety | special | normal | - |
| Operators Required | greater | avg. | fewer |
| Operational Complexity | difficult | avg. | simple |
| Power Efficiency | low | avg. | high |
| Auxiliary Needs | (no auxiliary need or specific need) | | |
| Residuals Aspects | difficult | avg. | good |
| Spoils Disposal | difficult | avg. | simple |
| Air Emissions Control | difficult | avg. | none |
| Noise Control | difficult | avg. | good |
| Aesthetics | - | avg. | good |
| Effluent Quality | low | avg. | high |

Capital Costs and Operation and Maintenance Costs

For both of these cost criteria, the unit processes were compared on the basis of relative costs. The basis of comparison was the reference unit process presented above. Several sources were used to develop relative costs including published cost curves, actual bid costs, and costs supplied by manufacturers. Most unit processes that achieve the same function are similar in cost.

Only unit processes that are significantly lower or higher in costs than the reference unit process will be noted in the discussion. If the capital or operation cost of a particular unit process exceeds the reference unit cost by 50 percent, that unit process will likely be eliminated from further consideration.

Reliability

Reliability is defined as the level of assurance that the unit process will consistently achieve the required degree of treatment under the expected range of operating conditions. This criterion takes into account the track record of the unit process at other large municipal wastewater treatment facilities. For this study, unit processes are rated using one of three levels of reliability: "high", "average", or "low". Unit processes ranked "high" consistently achieve the required degree of treatment. A unit process ranked "average" can be expected to have occasional process upsets but normally meets standards and is comparable to the reference unit process. A unit process ranked "low" has a record of poor reliability or represents a new unproven process.

Flexibility

Flexibility is defined as the degree to which a unit process will operate under upset conditions or major changes in flows or loadings. An upset condition may be defined as out of normal range but anticipated. For this study, unit processes are rated using one of three levels of flexibility: "high", "average", or "low". A unit process ranked "high" is not significantly affected by upset conditions or changes in flow or loadings. Unit processes ranked "average" are sometimes affected by these conditions, and unit processes ranked "low" cannot be expected to achieve design requirements during upset conditions such as changes in flow or loadings.

Constructibility

Constructibility takes into account many aspects of the construction of a unit process. These include the degree of construction difficulty, duration, and scheduling. The constructibility of a unit process will also be influenced by the degree to which supporting barge and staging areas are required. For this study unit processes are rated as presenting "difficult" conditions for construction or presenting "normal" conditions.

Safety

Safety is a criterion used to judge the level of precautions needed to reduce risks to plant personnel or the surrounding community. For some unit processes special safety precautions are required during operation. For other unit processes only normal safety precautions are required for operation. Therefore, two levels of safety are used in rating unit processes in this report: "special" and "normal".

Operators Required

This criterion is a measure of the relative number of operators and maintenance personnel required to successfully operate and maintain the unit process as compared to the reference unit process. For this study three levels of operators required are cited: "greater," which indicates a staff larger than the average required for the reference unit process; "average" number; or "fewer" number than average required to operate and maintain the reference unit process.

Operational Complexity

Operational complexity is defined as the degree of difficulty in the maintenance and control of a unit process. It is directly proportional to the level of skill required by plant operators to successfully operate the unit process. Average operational complexity means the unit process requires similar skills compared to the reference unit process. For this study three levels of operational complexity are cited: "difficult", "average," and "simple". The simple rated unit process will not require as high a skill level for operators in order to operate successfully. A difficult unit process will require more highly skilled operators compared to the reference unit process for successful operation.

Power Efficiency

Within each functional area power is required to achieve the desired degree of treatment. A unit process rated as "high" for power efficiency uses less power than the reference process to achieve similar degrees of treatment. A unit process rated "average" is similar in power needs to the reference process. A unit process rated as "low" for power efficiency uses more power than the reference process to achieve similar degrees of treatment.

Auxiliary Needs

Certain unit processes require significant auxiliaries to support the process, such as plant water for washing or chemical feed facilities. Needs were noted for these unit processes. If the unit process does not require any auxiliary equipment or utilities, the notation "none" was entered.

Residuals Aspects

Residuals aspects are defined as the level of difficulty of collection, processing, and disposal of residuals. Residuals include primary and secondary sludges, scum, grit, and screenings. This criterion takes into account both the quality and quantity of residuals generated by unit processes. A unit process rated "difficult" generates a greater amount of residuals or residuals more difficult to collect, process, or dispose of compared to the reference unit process. A unit process rated "average" is similar to the reference unit process in residuals aspects. A unit process rated "good" either generates fewer residuals compared to the reference unit process, or achieves the collection, processing, and disposal of those residuals more easily than does the reference unit process.

Spoils Disposal

Construction of unit processes will require excavation of soil and subsequent disposal at either on-island or off-island locations. Unit processes that require minimal excavation will reduce the volume of spoils requiring disposal. For this study, spoils disposal is rated as "difficult" compared to the reference unit process, "average" if it is similar to the reference unit process, or "simple" if it produces significantly less spoils than the reference unit process.

Air Emissions Control

Air emissions control is defined as the potential for generating air emissions and therefore, indirectly, as an indication of the level of control necessary to limit air emissions from a unit process. Volatile material is emitted from nearly all unit processes. Production is greater where turbulence is greater. For these unit processes the level of control is greater to minimize the effects of these emissions. For this study, a unit process rated "difficult" has a greater potential for emissions and requires a complex method to collect air emissions, or the area over which collection is required is extensive compared to the reference unit process. A unit process rated "average" emits a similar amount of pollutants and requires similar control as compared to the reference unit process. A unit process rated "none" does not produce significant air emissions and is not normally equipped with air emission control equipment.

Noise Control

Noise control is defined as the ease of controlling the noise generated during operation of a specific unit process. For this study, a unit process rated "difficult" has a potential for a high noise level and requires a greater level of control compared to the reference unit process. A unit process rated "average" produces noise and requires noise control mitigation to about the same degree as the reference project. A unit process rated "good" produces only low levels of noise that are simply controlled as compared to the reference unit process.

Aesthetics

Aesthetics is defined as the relative visual impact of a unit process on the surrounding communities and adjacent marine users. Unit processes are rated as either "good" or "average". A unit process ranked "good" is normally housed in a building where the building itself can be treated architecturally, or the process has a very low profile compared to the reference unit process. A unit process ranked "average" may have a high profile, may have a large amount of exposed equipment, or have other attributes that would require normal screening or other architectural treatment.

Effluent Quality

Effluent quality is defined as the relative impact of a unit process on downstream unit processes or the receiving water. A unit process rated "high" achieves results better than the reference unit process. A unit process rated "average" is similar to that achieved by the reference unit process. A unit process rated "low" does not meet the same standards as the reference unit process.

## 4.4 DETAILED EVALUATION CRITERIA

As part of the Secondary Treatment Facilities Plan development, major decisions will be made to select a wastewater treatment process; to size and locate conduits and pumping stations to convey wastewater to, and treated effluent from, the Deer Island Treatment Facility; and to plan the initial site preparation program at Deer Island. The purpose of this section is to describe the criteria that will be used to evaluate alternatives. These criteria include the criteria used during earlier screening of unit processes as well as additional criteria applicable to the detailed analysis. Evaluation criteria for outfall selection will be finalized at a later date following discussions with interested parties. Evaluation criteria for residual management and combined sewer overflows are subjects of separate facilities plans.

The remaining project components include the plant, the inter-island wastewater conduit, and site preparation. Table 4.4-1 lists all of the evaluation criteria and their respective indicators.

Certain criteria are common to all of the project components. They are presented in Section 4.4.1. Sections 4.4.2 through 4.4.4 describe criteria specifically applicable to each of the other project components as follows:

Section 4.4.2 Specific Criteria for Evaluation of Wastewater Treatment Alternatives

Section 4.4.3 Specific Criteria for Evaluation of Inter-island Wastewater Transport System Alternatives

Section 4.4.4 Specific Criteria for Evaluation of Site Preparation Alternatives

**TABLE 4.4-1**
**SECONDARY TREATMENT FACILITIES PLAN**
**PROPOSED CRITERIA FOR DETAILED EVALUATION OF ALTERNATIVES**

| Criteria | PROJECT COMPONENTS: Wastewater Treatment Plant | Inter-Island Conveyance | Early Site Preparation | Indicators |
|---|---|---|---|---|
| COST | | | | |
| Present Worth Costs | X | X | X | Millions of Dollars |
| Capital Costs | X | X | X | Millions of Dollars |
| Annual Operation and Maintenance Costs | X | X | | Millions of Dollars Per Year |
| TECHNICAL | | | | |
| Area Requirements | X | X | X | Acres |
| Reliability | X | X | | Acceptable, High |
| Flexibility | X | X | X | Acceptable, High |
| Constructibility | X | X | X | Aggravated, Moderate, Minimal |
| Personnel Safety | X | | | Special, Typical |
| Staffing Requirements | X | | | Number of Personnel |
| Operational Complexity | X | | | Difficult, Modest Typical |
| Power Needs | X | | X | Millions of Dollars Per Year |

**TABLE 4.4-1**
**SECONDARY TREATMENT FACILITIES PLAN**
**PROPOSED CRITERIA FOR DETAILED EVALUATION OF ALTERNATIVES**
**(continued)**

| Criteria | PROJECT COMPONENTS: Wastewater Treatment Plant | Inter-Island Conveyance | Early Site Preparation | Indicators |
|---|---|---|---|---|
| TECHNICAL (cont) | | | | |
| Chemical Requirements For Operation | X | | | Pounds per Day by Type |
| Quantity of Residuals Generated | X | | | Tons Per Day |
| Quality of Residuals Generated | X | | | Difficult, Modest, Typical |
| Quantity and Quality of Spoils | X | X | X | Cubic Yards |
| ENVIRONMENTAL | | | | |
| Air Emission Control | X | X | X | Volume Requiring Treatment |
| Noise Control | X | X | X | Difficult, Modest, Minimal |

**TABLE 4.4-1**
**SECONDARY TREATMENT FACILITIES PLAN**
**PROPOSED CRITERIA FOR DETAILED EVALUATION OF ALTERNATIVES**

| Criteria | PROJECT COMPONENTS: Wastewater Treatment Plant | Inter-Island Conveyance | Early Site Preparation | Indicators |
|---|---|---|---|---|
| ENVIRONMENTAL (cont) | | | | |
| Traffic | X | X | X | Number of Truck Trips per day or Significant, Modest, Minimal |
| Marine Resources | | X | X | Significant, Modest, Minimal |
| INSTITUTIONAL | | | | |
| Timely Implementation | X | X | X | Difficult, Modest |
| Permitting | X | X | X | Extensive, Modest |
| External Coordination | X | X | X | Extensive, Modest Minimal |
| Internal Coordination | X | X | X | Extensive, Modest Minimal |
| Demand for Unique or Scarce Resources | X | X | X | Difficult, Modest |
| Flexibility to Meet Project Phasing | | | X | None, Fair, Good |

Specific criteria for the evaluation of Effluent Outfall alternatives will be discussed in Volume V, Effluent Outfall.

The description of these criteria will enable the reader to understand how a particular criterion will be used to rate an alternative. No weighting factors have been assigned to any of the criteria. The alternatives will not be ranked. Rather, the criteria will be used to display sufficient information about each alternative so that decisions can be made in selecting the recommended plan.

Tables 4.4.5-1 and 4.4.5-2 in the next section describe how the criteria used during the siting of this plant and MWRA's previous commitments to mitigation are incorporated in the evaluation criteria.

### 4.4.1 COMMON EVALUATION CRITERIA

The evaluation criteria that are common to all project components are as follows:

#### Air Emissions Control

Air emissions control is defined as the potential for generating odor/air emissions and therefore, indirectly, as an indication of the level of control necessary to limit air emissions from wastewater treatment, transport and site preparation activities. For each alternative, the total volume of air requiring treatment will be estimated. The ambient concentration of emissions including odors and their impact on plant personnel and neighboring communities will also be evaluated in accordance with State guidelines.

#### Noise Control

MWRA has committed to a program to comply with stringent noise mitigation and to develop a program to avoid adverse noise impacts during construction and operation. Since all alternatives will meet these commitments this criterion is defined as the ease of controlling the noise generated during construction and operation. Wastewater project component alternatives rated "difficult" have a potential for high noise levels and require a greater level of control. An alternative rated "modest" produces noise and requires noise control mitigation to about the same degree as typical wastewater transport and treatment facilities or as typical site preparation projects. Alternatives may be rated "low" if little or no noise control is required.

#### Environmental

This set of criterion measures a project component's effect on selected environmental items. The list below is based on EPA guidance for facilities planning. Each alternative will be evaluated (where applicable) for impacts to:

- o Historical and archaeological sites
- o Floodplains, wetlands and barrier beaches

- o Fish and wildlife protection
- o Endangered species protection
- o Recreational opportunities

Alternatives will be rated as having "minimal", "modest", or "significant" effect.

Traffic

MWRA has committed to limit the traffic through Winthrop during both construction and operation of the treatment facilities. As a major element of that committment the MWRA is in the process of contracting a pier facility for the movement of materials by either barging or Roll/On-Roll/Off. Where differences exist among alternatives in the amount of equipment or materials to be transported to the site, the number of trick trips and/or barge trips for personnel, materials, and equipment during construction will be estimated. Differences will also be shown for the number and type of trips required during operation.

Area Requirements

For each project component, alternative preliminary layouts will be prepared. For the wastewater treatment alternatives, all processes require multiple units, therefore, the space between processes will be taken into account in determining total process area. Areas for ancillary facilities, roadways and interprocess conveyance will be added to the process area. For other project components (transport, outfall and site preparation), area requirements for alternatives will also be presented.

Quantity and Quality Of Spoils for Disposal and/or Relocation

Construction of new transport and treatment facilities will require the movement of large quantities of soil and its subsequent disposal/use at either on-island or off-island locations. For this study, the total volume (cubic yards) of spoils requiring movement and the volume (cubic yards) requiring offsite disposal and/or reuse will be presented for each alternative. In addition, material that will require offsite disposal will be assessed as to the type and quality of material and the difficulty expected in ultimately disposing of this material.

Timely Implementation

Implementation is defined as the relative difficulty expected in maintaining the schedule for installation and/or expansion of the system in discrete, manageable components. For this study, two ratings are appropriate for this criteria: "moderate" and "difficult". For alternatives with features likely to make implementation difficult or to cause project delays, the "difficult" rating is used. For other alternatives with fewer challenges, the "moderate" rating is used.

Permitting

Permitting is defined as the measure of the relative difficulty in obtaining the necessary permits for an alternative. The alternatives will be rated "moderate" or "extensive" reflecting the relative time required to obtain a permit.

External Coordination Requirements

External coordination requirements are a measure of the relative degree to which the Authority must interact with other organizations to achieve the desired objectives. This includes consideration of legislative approval and other requirements necessitated by legal and jurisdictional limits to MWRA's authority. Alternatives are rated "minimal", "modest" or "extensive" depending on the degree of coordination required.

Internal Coordination Requirements

Internal coordination requirements are a measure of the relative degree of coordination required between Authority projects or programs such as the coordination required between the wastewater treatment section and the industrial waste section. Alternatives are rated "minimal", "moderate" or "extensive" depending on the degree of coordination required.

Demand For Unique Or Scarce Resources

This criterion is a measure of the demand that any one alternative may put on resources that are in scarce supply or not available in the local area. Key shortages of some labor skills and equipment may occur because of the concurrent construction of major projects such as the third harbor tunnel. Alternatives are rated "moderate" if potential conflicts exist, or "difficult" if demands clearly exceed supply.

Present Worth Costs

Present worth costs are the sum of those costs which, if invested now at a given interest rate, would provide exactly the funds required to construct and operate the project for the planning period. Present worth costs for each project component alternative will be presented in terms of millions of dollars. The design year of the project is 2020, twenty years after the planned startup of secondary treatment facilities and 25 years after the planned startup of new primary treatment facilities.

Capital Costs

Capital costs of alternatives will include costs to construct facilities, costs for equipment replacement during the planning period plus 35 percent to cover construction contingencies, administrative, engineering and legal costs. Any significant and special mitigation cost will be included in the alternative costs. Construction costs of necessary facilities in this plan do not include costs for land purchase. Financing, legal and administrative costs to implement the project will be presented only for the recommended plan. Capital costs will be presented in terms of millions of dollars.

Annual Operation And Maintenance Costs

Operating costs will include power, labor, chemical and utility costs and the cost of supplies. Power costs will include consideration of power company demand charges and credit for power produced on-site. Labor costs will be based on average salary levels including employee benefits. Annual operation and maintenance costs will be presented in terms of millions of dollars per year.

### 4.4.2 SPECIFIC CRITERIA FOR EVALUATION OF WASTEWATER TREATMENT ALTERNATIVES

The specific evaluation criteria that will be used for evaluation of treatment alternatives are described below.

Reliability/Flexibility

Reliability/Flexibility is defined as the degree to which a wastewater treatment alternative will accomodate an anticipated upset or a significant, generally unanticipated, equipment failure and still meet treatment standards. Overall flexibility will be a function of the design criteria selected for individual unit processes. This criterion is judged using the existing record of municipal wastewater experience and performance for individual unit process. Wastewater treatment alternatives are rated using one of two levels of reliability/flexibility: "acceptable" and "high". An alternative ranked "high" consistently achieves and frequently exceeds the required degree of treatment. An alternative ranked "acceptable" can be expected to have occasional process upsets but will continuously meet standards.

Constructibility

Constructibility takes into account many aspects of the construction of treatment facilities. These include the degree of construction difficulty, construction duration, and impacts on overall scheduling. Construction work will be divided up into appropriate packages depending on factors such as special labor skills required, degree of instrumentation or mechanical equipment installation. The number of work packages or contracts may impact the project schedule. For this study, wastewater treatment alternatives are rated as presenting "aggravated" conditions for construction, or as presenting "minimal" conditions for construction.

Personnel Safety

Safety is a criterion used to judge the level of precautions needed to reduce risks to plant personnel or to the surrounding community. For some unit processes special safety precautions are required during operation. For other unit processes only normal safety precautions are required for operation. Therefore, two levels of safety are used in rating unit processes in this report: "special" and "typical".

Staffing Requirements

This criterion identifies the approximate number of operators and maintenance personnel required to successfully operate and maintain a particular alternative wastewater treatment process. Management, supervisory and laboratory personnel needs will be about the same for each alternative and will be estimated for the recommended plan.

Operational Complexity

Operational complexity is defined as the degree of difficulty in the maintenance and control of a unit process. It is directly proportional to the level of skill required by plant operators to successfully operate the unit process. Average operational complexity means the unit process requires similar skills as compared to the reference unit process. For this study three levels of operational complexity are cited: "difficult", "modest", and "typical". The "typical" rated unit process will not require as high an operator skill level for successful operation. A "difficult" unit process will require more highly skilled operators to achieve successful operation compared to the reference unit process.

Power Needs

Within each functional area power is required to achieve the desired degree of treatment. (Preliminary treatment, primary treatment, secondary treatment and clarification, disinfection, and influent and effluent pumping.) For each alternative the total power required will be presented in kilowatts.

Quantity of Residuals Generated

Residuals refer to the sludge, screenings, grit and scum removed from the wastewater during treatment. These residuals require processing and disposal. For each alternative the total weight or volume of residuals, by type, will be presented.

Quality of Residuals Generated

Since all wastewater treatment alternatives treat the same influent, the quality of residuals generated will be generally similar. However, different unit processes may remove residuals in a manner that affects their characteristics. This may impact the degree of difficulty in processing or disposing of residuals. For this criterion, a unit process that generates residuals that are more difficult to manage than those of a typical secondary treatment facility will be identified. The three levels of residuals quality cited are "typical" and "difficult".

Chemical Requirements for Operation

For those alternatives requiring chemicals, the type and quantity will be presented. THE quantity will be presented in terms of pounds per day, or in other appropriate measurements. Hazardous chemicals will be identified and chemical requiring any special handling will be identified.

Visual Impacts

This criterion addresses the visual impact of the wastewater treatment facilities both at deer island and the headworks facility at nut island. The current profile of Deer Island includes the central drumlin which rises 100 ft above water level, the existing plant, the prison, and other natural and manmade features. The current profile of Nut Island is dominated by the existing plant. The visual impact is assesed as resulting in "minimal", "modest" or "significant" change to the Islands. At Deer Island the impact is evaluated from several points of view: the nearby residents of Point Shirley; the more distant residents of the town of Winthrop; and a view from the west or southwest which could represent a view

from Boston or from marine users of Boston Harbor. At Nut Island the impact is evaluated from Hough's Neck and the Quincy shoreline.

Flexibility to Meet Future Changes

This criterion evaluates the wastewater treatment alternatives according to the relative ease with which they could be modified to accommodate future changes in treatment standards. The ease of adaptation is assessed as either "none", "fair" or "good".

### 4.4.3 SPECIFIC CRITERIA FOR EVALUATION OF INTER-ISLAND WASTEWATER TRANSPORT SYSTEM ALTERNATIVES

In this section, evaluation criteria that will be used in the detailed evaluation of inter-island wastewater transport system alternatives will be described. The major alternatives being studies are a buried pipeline, a deep rock tunnel, or a combination of methods that will transport wastewater from the Nut Island headworks facility to the Deer Island plant.

Reliability

Reliability is defined as the level of assurance that the inter-island wastewater transport system will continuously operate over the expected range of operating conditions throughout the life of the project. Reliability is a criterion in selecting and arranging active components of the system such as electrical and mechanical equipment. Reliability is not a criterion in selecting and arranging passive components of the system such as structures, buried pipelines, and tunnels.

The reliability of pumping station equipment alternatives are rated using two levels: "acceptable" and "high". Alternatives ranked "high" are expected to operate continuously without system impact. Alternatives ranked "acceptable" can be expected to have infrequent equipment outages. In all cases, however, back-up pumping capacity will be available from standby units.

Flexibility

Flexibility is defined as the degree to which a hydraulic transport system alternative will accommodate an upset or a significant, generally unanticipated, equipment failure. An upset condition may be defined as other than normal, but anticipated. For this study, alternatives are rated using one of three levels of flexibility: "low" or "medium" or "high". Alternatives ranked "high" are not significantly affected by upset conditions. Alternatives ranked "medium or "low" are sometimes affected by these conditions but will meet standards.

Constructibility

Constructibility is defined as the level of assurance that the inter-island transport system will be constructed on schedule. Constructibility is a criterion used in evaluating the

transport conduit alternatives: buried marine pipeline versus deep rock tunnels. This criterion includes availability of labor skills, equipment and materials; proven, as opposed to state-of-the-art, construction methods; and the impact of adverse weather. Alternatives are discribed as having "minimal", "moderate" or "aggravated" conditions for construction.

Marine Resources

Potential impacts to marine resources associated with the construction of alternative inter-island wastewater transport systems will be compared. In general, those alternatives involving construction within the marine environment may be characterized as having a "minimal," "modest" or "significant" potential for either short- and/or long-term impact to the affected resources. Impacts may be direct, such as displacement of biota or removal of benthic habitat by dredging or by marine spoil disposal, or impacts may be indirect to the marine biota by releasing potentially toxic constituents.

### 4.4.4 SPECIFIC CRITERIA FOR EVALUATION OF SITE PREPARATION ALTERNATIVES

The following sections described the specific evaluation criteria that will be used during the detailed evaluation of site preparation alternatives. Site preparation is defined as those construction activities required at Deer Island (e.g. removal of central drumlin, prison facilities, bunkers) before the new primary treatment facilities are constructed.

Flexibility

Flexibility is defined as the degree to which site preparation activities do not preclude the feasability of possible options for engineering, construction and operation of existing and proposed treatment facilities. Alternatives ranked "high" offer the greatest flexibility, i.e., the fewest restraints. Alternatives ranked "acceptable" indicate reduced flexibility. Alternatives rated as "limited" indicate significantly reduced ability to accomodate engineering options.

Constructibility

Constructibility takes into account many aspects of site preparation including the degree of construction difficulty, duration, access requirements, sequencing, and scheduling. Construction work will be broken into appropriate packages depending on special labor skills required and phase of work. For this study, site preparation alternatives are rated as presenting "minimal", "modest" or aggravated" conditions for construction.

Power Needs

Power is required to support site preparation alternatives. While the quantity of power required for site preparation is small in comparison to the ultimate pumping and treatment power needs, the demand may exceed the limited onsite supply. Thus, an offsite power supply, which currently doesn't exist, may be required early in the project. This criteria judges the

amount of power required and the date by which it is required.

Quantity and Quality of Spoils for Disposal and/or Relocation

Construction of new transport and treatment facilities will require the movement of large quantities of soil and its subsequent disposal/use at either on-island or off-island locations. For this study, the total volume (cubic yards) of spoils requiring movement and the volume (cubic yards) requiring offsite disposal and/or reuse will be presented for each alternative. In addition, material will require offsite disposal will be assessed as to the type and quality of material and the difficulty expected in ultimately disposing of this material.

Special Resources

Site preparation may require the removal or relocation of special resources such as historic structures and archaeological resources. An alternative which minimizes removal and maximizes reuse/relocation of resources that are removed is described as "minimal". An alternative which may require more infringement of these resources is described "modest". An alternative that requires significant infringement on these resources is described "significant".

Flexibility to Meet Project Phasing

This criterion evaluates the site development alternatives according to the relative ease with which they could be modified to accomodate larger area requirements for wastewater treatment as dictated by changes in treatment standards. The ease of adaptation is assessed as either "none", "fair" or "good".

### 4.4.5 APPLICABILITY OF OTHER CRITERIA AS DETAILED EVALUATION CRITERIA

During siting of the wastewater treatment plant, the MWRA developed eight criteria to assist in site selection. Table 4.4.5-1 provides a description of each siting criteria and a statement of its applicability for use as evaluation criteria.

A significant mitigation package was developed as an integral part of MWRA's decision to site the new secondary treatment facilities on Deer Island. Because the MWRA is committed to alleviating the impacts associated with the construction and operation of the treatment facilities, the previous mitigation commitments are also an integral part of the facilities planning process.

Table 4.4.5-2 provides a summary description of each of the mitigation commitments, and a statement of the applicability of each commitment for use as an evaluation criterion.

## TABLE 4.4.5-1

## APPLICABILITY OF PLANT SITING CRITERIA AS EVALUATION CRITERIA

| SITE SELECTION CRITERIA | APPLICABILITY OF CRITERIA |
|---|---|
| 1. Reliability<br><br>Measures the ability of each alternative to promote the overall integrity of the wastewater treatment system. | Reliability considerations are included in treatment, inter-island transport, and outfall evaluation criteria. |
| 2. Effect on Neighbors<br><br>Measures each alternative's impact on those in close proximity to the treatment plant and on those impacted by the construction of the facility. Impacts analyzed were odor, noise, property values and health and safety. | Odors, noise, visual affects and health and safety considerations are included in evaluation criteria for the pertinent project components. The remaining considerations are discussed in the section on mitigation commitments. |
| 3. Equitable Distribution Of Regional Responsibility<br><br>Measures the degree to which any one community is asked to shoulder a disproportionate share of the impacts associated with living and working in a major metropolitan area. | This criterion is not considered for the project components involving treatment wastewater transport to Deer Island, and site preparation. It may be used in development of outfall siting criteria. |

**TABLE 4.4.5-1**

**APPLICABILITY OF PLANT SITING CRITERIA AS EVALUATION CRITERIA (continued)**

| SITE SELECTION CRITERIA | APPLICABILITY OF CRITERIA |
|---|---|
| 4. Cost | |
| Measures the financial resources that must be invested in the facility under each alternative. | Costs criteria are described and considered in all project components. |
| 5. Implementability | |
| Measures the ability of each alternative to be brought to reality in a timely and predictable manner. This criterion considered construction schedules, the permitting process, and other institutional aspects. | Implementation and permitting are considered in all project components. |
| 6. Harbor Enhancement | |
| Measures each alternative's consistency with, and potential for, improvement of Boston Harbor's role in the economic and social life in the Greater Boston area. This criterion was used to judge which harbor island had a greater potential for recreational opportunities. | Harbor enhancement is the goal of all the alternatives considered but is not specifically included in the evaluation criteria. |
| 7. Effect On Natural And Cultural Resources | |
| Measures each alternative's effect on important resources in the harbor. This criterion was used to weigh the relative importance of historic and archaeologic sites and barrier beaches and wetlands on the candidate harbor islands. | These considerations are described and considered in all project components. |

**TABLE 4.4.5-1**

**APPLICABILITY OF PLANT SITING CRITERIA AS EVALUATION CRITERIA (continued)**

| SITE SELECTION CRITERIA | APPLICABILITY OF CRITERIA |
|---|---|
| 8. Mitigation | |
| A significant mitigation package was developed as an integral part of MWRA's decision to site the new secondary treatment facilities on Deer Island. MWRA is committed to alleviating the impacts associated with the construction and operation of the treatment facilities. | The next section discusses each mitigation commitment and its applicability as an evaluation criterion for alternatives. |

## TABLE 4.4.5-2

## APPLICABILITY OF COMMITMENTS TO MITIGATION AS EVALUATION CRITERIA

| MITIGATION COMMITMENTS | APPLICABILITY OF COMMITMENTS |
|---|---|
| 1. Flow and Growth | |
| MWRA has committed to an aggressive program to avoid overloading the new treatment facilities planned for Deer Island, and to avoid future expansion to the extent possible. MWRA will implement flow management techniques as well as a program to avoid excess pollutant loading. If necessary, future considerations may include flow control structures and satellite treatment plants to minimize peak flows. | Estimates of wastewater flow and pollutant loading have been employed as the basis for wastewater transport, treatment, and outfall project components. Since this commitment will be implemented independently of all alternatives being considered, it is not used as an evaluation criterion. It is the subject of a separate analysis in the facilities plan. |
| 2. Operations and Maintenance | |
| MWRA is committed to improved operations and maintenance. The facilities plan will initiate early planning of operations and maintenance considerations. | Operations and maintenance considerations are included in evaluation criteria and are pertinent to transport, treatment, and outfall project components. |
| 3. Odor Control | |
| MWRA is committed to the construction of a facility that will control odors: to eliminate detectable odors offsite, protect the public health, and to minimize, to the extent feasible, objectionable odors onsite. | Criteria for odors and other air emissions are considered in all project components. |

**TABLE 4.4.5-2**

**APPLICABILITY OF COMMITMENTS TO MITIGATION AS EVALUATION CRITERIA (continued)**

| MITIGATION COMMITMENTS | APPLICABILITY OF COMMITMENTS |
|---|---|
| 4. Noise Control | |
| MWRA has committed to compliance with all legal standards and has set a noise abatement goal that goes beyond simply adhering to applicable codes. MWRA will examine noise abatement throughout the planning, design, construction and operation of the facility to avoid adverse noise impacts. MWRA will also establish an acoustic review board and will solicit community involvement in the noise control program. | Criteria for noise control are considered in all project components. |
| 5. Barging and Busing | |
| MWRA is committed to the priority of the construction of on-island piers and to limit trucking volume during pier construction; upon completion of pier facilities, to barge almost all heavy construction equipment and materials with a limited level of contingency trucking; bus all construction workers; and investigate the practicality of providing ferries to transport construction workers. | Since this commitment will be implemented independently of all alternatives being considered, it is not used as an evaluation criterion. Special transportation needs are included as an evaluation criterion as regards construction support needs. |
| 6. Trucking of Liquid Chlorine | |
| MWRA has committed to cease the trucking of liquid chlorine through Winthrop immediately after site access facilities and feasible barging become available. | Since this commitment will be implemented independently of all alternatives being considered, it is not used as an evaluation criterion. |

**TABLE 4.4.5-2**

**APPLICABILITY OF COMMITMENTS TO MITIGATION AS EVALUATION CRITERIA (continued)**

| MITIGATION COMMITMENTS | APPLICABILITY OF COMMITMENTS |
|---|---|
| 7. Relocation of Deer Island House of Correction | |
| MWRA has determined that the Deer Island House of Correction must be relocated. | Since this commitment will be implemented independently of all alternatives being considered, it is not applicable for use as an evaluation criterion. |
| 8. Further Measures To Be Examined | |
| EOEA, in its final certification, recommended that MWRA consider earlier implementation of certain additional measures. Within this facilities plan, MWRA will further examine VOC's and air toxic controls. MWRA will examine other suggestions such as the concept of a "sewer bank", the utilization of satellite plants, additional flow measurements, odor panel formation, odor monitoring, and formation of an acoustic review board. | Air emission control and noise considerations are considered in all project components. Other considerations will be independent of all alternatives being considered and therefore are not used as evaluation criteria. |

## 4.5 GUIDELINES FOR COST EVALUATION

In order to use cost-effectiveness comparisons of the treatment alternatives considered for detailed analysis, these guidelines for unit process cost evaluation and procedures for determining life-cycle costs have been developed based on EPA cost-effectiveness guidelines. Common parameters to be used in all cost effectiveness comparisons include design lives, discount rate, salvage values, and base year for analysis.

Life-cycle cost factors have been prepared for the outfall project, the inter-island conveyance project, the design and construction of the primary treatment facilities, and the design and construction of the secondary treatment facilities due to the phased construction. The derivation of these factors and the common parameters used in the development of these factors are explained in the following paragraphs.

### 4.5.1 DISCOUNT RATE

At the start of each fiscal year, EPA establishes the discount rate to be used for life-cycle cost analyses. The rate to be used for this analysis is 8-5/8 percent, the rate established by the Water Resources Council as of October 1, 1985.

Several of the events on the life-cycle cost diagram do not occur at one year intervals. Because of this, the life-cycle cost analysis factors generated for the facilities planning have been developed using a monthly discount rate of 0.71875 percent (8-5/8 percent divided by 12), and payments have been divided into monthly periods.

### 4.5.2 BASE YEAR AND PLANNING PERIOD FOR ANALYSIS

The base month selected for the cost analysis is January, 1990. The year 1990 represents the first year of projected construction activity for primary treatment facilities. Although the projected start-up for construction is not until July of that year, it was considered much easier to use the beginning of the year as a base rather than seven months into the year.

The end of the life cycle of the project will be January, 2020. This provides for 20 years of operation of the completed secondary treatment facilities.

### 4.5.3 CONSTRUCTION COST INDEX

The construction costs used for based on September, 1986 prices. The Construction Cost Index, as presented in the Engineering News Record (ENR-CCI) for September, 1986, is 4332.5. To simplify, use 4330 for the baseline cost index.

### 4.5.4 COST ESCALATION FACTORS FOR ENERGY USE AND WASTEWATER FLOW INCREASES

There will be no escalation of energy or chemical costs for the purposes of the cost-effectiveness comparisons. Cost escalation for energy and chemicals will be considered as

part of a sensitivity analysis. Different rates will be used to determine potential impacts on total present worth costs of the relative ranks of alternatives. None of the costs will be weighted according to flow. It is unlikely that one alternative would have an appreciably higher flow-dependent cost than another. In addition, the average flow in 1986 is approximately 93 percent of the ultimate average flow. This difference in flow is not enough to warrant a difference in number of staff. And the difference in energy and chemical requirements would not be appreciable.

### 4.5.5 LIFE EXPECTANCIES

The life expectancies of cost items are important for use in determining future replacement costs and salvage values at the end of the project period. The life expectancies to be used for these projects are as follows: 5 years for vehicles; 15 years for all equipment; and 50 years for buildings, structures, and pipelines.

### 4.5.6 LAND COSTS

The MWRA either owns or is statutorily permitted to use all land on Deer Island. The cost of land is not expected to become a part of the life cycle cost analysis. The land requirements are independent of the treatment process selected since all excess area will serve as a buffer zone. Also, in accordance with the cost effectiveness guidelines, the land values must be salvaged at the end of the planning period and therefore would be negligible in the final cost effectiveness comparison. Therefore, there is no need to consider land costs in the life-cycle cost analysis.

### 4.5.7 PROJECT COSTS

The term "project cost" is used throughout the discussion of cost factors. This cost consists of the estimated capital construction cost plus the cost of engineering and contingencies. The sum of engineering and contingency costs was estimated to be 35 percent of the installed cost. In other words, the estimated installed cost of an item will be multiplied by a factor of 1.35 to yield the project cost.

### 4.5.8 INTEREST DURING CONSTRUCTION

Interest during construction was calculated based on the following:

- Uniform cash flow over construction period (therefore, constant gradient of interest payments)
- Discount rate of 8-5/8 percent per year
- Monthly payments of interest due
- No investment dividends on borrowed money not yet paid on the project

- o Gradient series of interest payments converted to annual and then present worth cost

### 4.5.9 ANNUAL COST

Annual costs are those costs paid each year to keep the facilities in good operating order and to preserve the lives of structures and equipment. The following items, among others, are included:

- o Wages and salaries
- o Maintenance items
- o Energy consumption
- o Chemicals

The labor cost for the plant's operation and maintenance staff, including fringe benefits, averages $30,000 per year. The annual maintenance cost which includes lubrication oils, replacement parts, and other maintenance items, is estimated at one percent of the equipment capital costs. The cost of electric power is $0.055/kwh. Chemical costs for the biological treatment alternatives include gaseous hydrochloric acid for cleaning the diffuser discs of the fine bubble diffused air and coupled system alternatives. Chemicals are also required for the disinfection alternatives. For one alternative, sodium hypochlorite must be purchased, while for onsite sodium hypochlorite generation, nitric acid is used for cleaning the generation cells. For the two disinfection alternatives using sodium hypochlorite, dechlorination may be determined necessary. If this is the case, then gaseous sulfur dioxide would have to be purchased. The unit costs for the hydrochloric acid is $65 per ton. The unit cost for the sodium hypochlorite is $0.35 per gallon; $7.10 per gallon for the nitric acid; and $0.15 per pound of sodium dioxide.

### 4.5.10 BASIS OF COST COMPARISON

All cost comparisons are made in terms of present worth costs instead of equivalent annual costs. This has been done to avoid confusion between equivalent annual costs and annual operating and maintenance costs. Present worth costs provide a convenient method to evaluate one time capital costs and the annual costs of the alternatives on an equivalent basis. Relative rankings of alternatives will not change whether present worth or equivalent annual cost is the method of comparison.

Table 4.5.10-1 has been prepared with both 1990 and the start-up date of the individual item as base years. Present worth factors at the start-up date have been prepared because in the case of secondary treatment, translating future costs to present worth makes them appear deceptively low.

## TABLE 4.5.10-1
## SUMMARY OF LIFE-CYCLE COST FACTORS

| Item | Factor For Present Worth at Base Year-January 1990 |
|---|---|
| Outfall Project | 0.77 Cout +6.99 Aout |
| Inter-Island Conduit | 0.76 Ctun +6.66 Atun |
| Primary Treatment Facilities Project | 0.94 Cpe +0.76 Cps +2.01 Cpv +6.35 Ap |
| Secondary Treatment Facilities Project | 0.61 Cse +0.50 Css +1.03 Csv +4.03 As |

Notes:

1. Final Project Month = January, 2020
2. Discount Rate = 0.71875% per month (based on 8-5/8% per year)
3. Abbreviations
   - Cout - Project Cost of Outfall
   - Aout - Annual Maintenance Cost for Outfall
   - Ctun - Project Cost of Inter-Island Conduit
   - Atun - Annual Maintenance Cost For Inter-Island Conduit
   - Cpe - Project Cost of Primary Treatment Equipment
   - Cps - Project Cost of Primary Treatment Buildings Structures, and Pipelines
   - Cpv - Project Cost of Primary Treatment Vehicles
   - Cse - Project Cost of Secondary Treatment Equipment
   - Css - Project Cost of Secondary Treatment Buildings, Structures, Pipelines
   - Csv - Project Cost of Secondary Treatment Vehicles
   - Ap - Annual Operations and Maintenance Cost for Primary Treatment
   - As - Annual Operations and Maintenance Cost for Secondary Treatment
4. Life Expectancies

| | |
|---|---|
| Equipment | 15 Years |
| Buildings, Structures, Pipelines | 50 Years |
| Vehicles | 5 Years |

# Section 5

# 5.0 EXISTING CONDITIONS

This section has three main parts; (1) a description of the MWRA wastewater collection and treatment system, (2) a description of the existing environment, and (3) a description of historical and archeological resources.

## 5.1 WASTEWATER COLLECTION AND TREATMENT SYSTEM

This section presents a description of the current wastewater collection and treatment facilities and the on-going program to upgrade the existing Deer Island and Nut Island Wastewater Treatment Plants and the existing headworks on the North Metropolitan Sewer System. Solids-handling-related facilities are the subject of a separate facilities plan and are not specifically addressed as part of this description. The on-going rehabilitation program, called Fast-Track Improvements, is intended to provide reliable treatment until existing facilities are replaced or improved during construction of the new treatment facilities.

### 5.1.1 WASTEWATER COLLECTION SYSTEM

The MWRA's wastewater collection system consists of a North System and a South System. North System flows are collected and transported to the Deer Island Treatment Plant. South System flows are collected and transported to the Nut Island Treatment Plant.

#### North System

Influent flow enters the Deer Island plant through both the Main Pumping Station and the Winthrop Terminal Headworks.

The Main Pumping Station at Deer Island can pump from either of two deep rock tunnels, each constructed 300 feet below sea level. The first tunnel, the Boston Main Drainage Tunnel, is approximately 7 miles long. It crosses under Boston Harbor from Deer Island to South Boston where it connects to the Columbus Park Headworks. The Boston Main Drainage Tunnel continues from Columbus Park to the Ward Street Headworks located off of Huntington Avenue, near the Wentworth Institute of Technology. The second rock tunnel, the North Metropolitan Relief Tunnel, is approximately 4 miles long. In connects the Chelsea Creek Headworks to the Main Pumping Station at Deer Island. The Main Pumping Station has no wet well and the two tunnels are not connected. Each pump can draw from either tunnel, and the suction connection to each tunnel is controlled by air operated butterfly valves.

The Winthrop Terminal Headworks screens and pumps influent flow that arrives at Deer Island via the North Metropolitan Trunk Sewer. This sewer is the original interceptor to Deer Island and is roughly paralleled by the North Metropolitan Relief Tunnel. The North Metropolitan Trunk Sewer receives flows from Winthrop, Orient Heights, and Deer Island, and overflows from the Chelsea Creek Headworks via the East Boston Pumping Station. The North Metropolitan Trunk Sewer has a peak capacity of 125 mgd. The Winthrop Terminal was designed to screen this entire flow and to provide grit removal for 60 mgd. Flows receiving grit removal are discharged to the primary plant. Flows in excess of the capacity of the grit system are

discharged directly to the Deer Island Plant bypass.

The North System components are shown schematically in Figure 5.1.1-1. During peak flows, normally caused by wet weather flows from the numerous combined sewers of the North Metropolitan System, the Boston Main Drainage and North Metropolitan Relief Tunnels are selectively throttled at the three remote headworks, thereby diverting flows in excess of the plant's capacity to combined sewer overflows.

When the Ward Street Headworks is throttled, the majority of excess flow is diverted to the Cottage Farm Chlorination Facility which discharges to the Charles River.

When the Columbus Park Headworks is throttled, the majority of excess flow is diverted to the Calf Pasture Pump Station, located at Columbia Point, which pumps the wastewater to the Moon Island Outlet which discharges to Dorchester/Quincy Bay.

At Chelsea Creek, excess flow is diverted, via a siphon, across the creek to the East Boston Pump Station and is pumped from there into the North Metropolitan Trunk Sewer.

The North System is operated to maximize the flow from both the Chelsea Creek Headworks and the inter-connected Winthrop Terminal Headworks/East Boston Pump Station System. Because flow from Chelsea Creek Headworks is optimized, the system initially throttles flow at the Ward Street Headworks and, if necessary, at the Columbus Park Headworks.

The hydraulic capacities of the existing major conveyance facilities in the North and South Systems are presented in Table 5.1.1-1.

South System

The South Metropolitan Sewerage System's High Level Sewer conveys wastewater to the Nut Island Treatment Plant in Quincy. There are no remote headworks on the South Metropolitan Sewerage System. The High Level Sewer is fed by various upstream interceptors and force mains.

The South Metropolitan Sewerage System consists of a network of approximately 78 miles of MWRA interceptor sewers, five pump stations which are owned and maintained by the MWRA, and the existing Nut Island treatment plant.

The High Level Sewer (HLS), begins in the Parker Hill section of Roxbury, just south of the North Metropolitan System's Ward Street Headworks. The HSL's length is about 15 miles and extends through Hyde Park, Milton and Quincy to the Nut Island Plant. Along the sewer route, major flows are received from MWRA extension sewers including the Brighton Branch, Neponset Valley Sewer, Upper Neponset Valley Sewer, New Neponset Valley Sewer, Wellesley Extension Sewer, and the Wellesley Extension Relief Sewer.

Influent flows are also received from the Merrymount, Squantum, Braintree-Weymouth, and Houghs

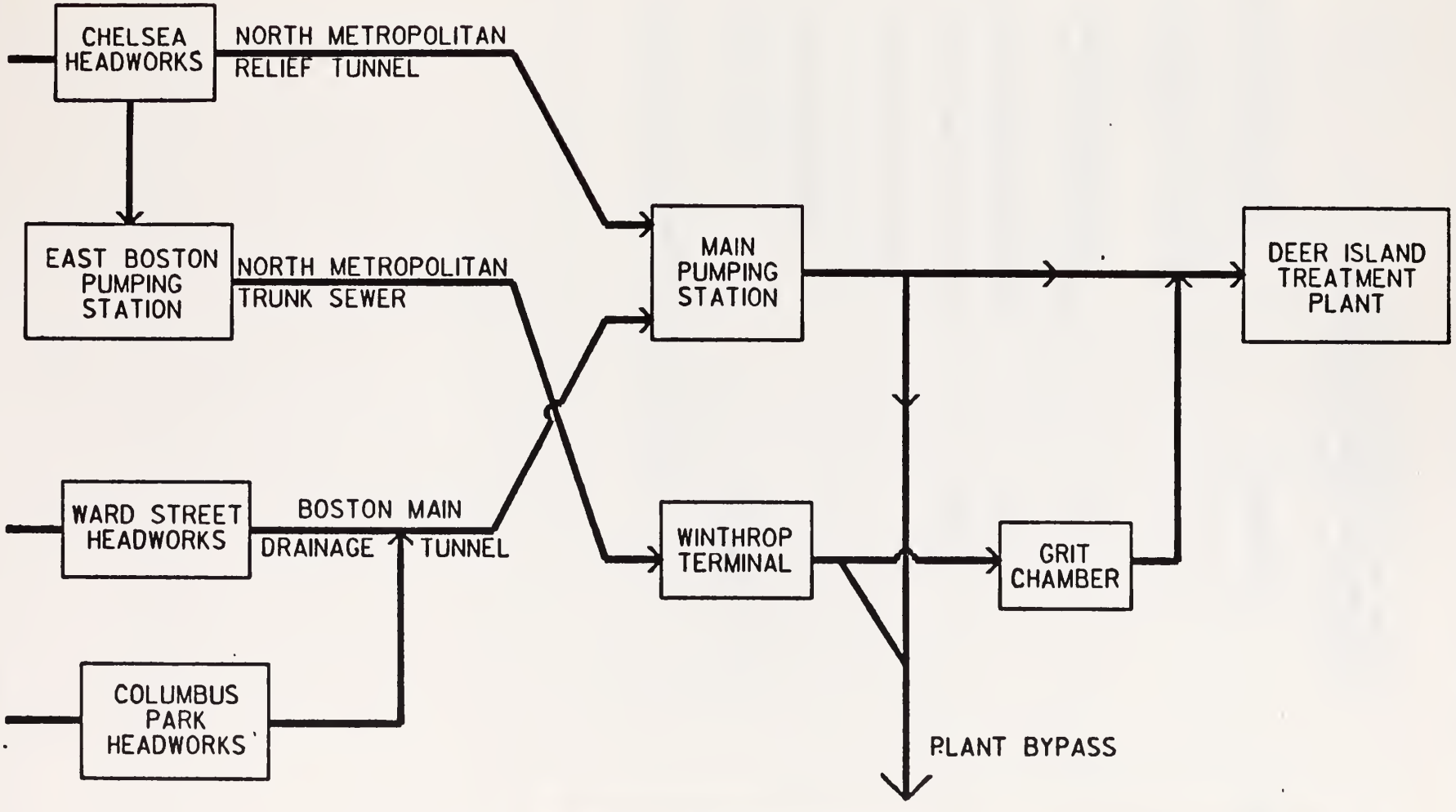



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**FIGURE 5.1.1-1**
**EXISTING NORTH SYSTEM TUNNEL AND HEADWORKS SCHEMATIC**

**TABLE 5.1.1-1**
**HYDRAULIC CAPACITY OF MAJOR NORTH AND SOUTH METROPOLITAN CONVEYANCE FACILITIES**

| North Metropolitan System | Size of Line | Peak Capacity (mgd) |
|---|---|---|
| Boston Main Drainage Tunnel Deer Island P.S. to Columbus Park Segment | 11 ft - 6 in | 438 |
| Boston Main Drainage Tunnel Columbus Park to Ward St. Segment | 10 ft | 256 |
| North Metropolitan Relief Tunnel | 10 ft | 350 |
| North Metropolitan Trunk Sewer | 108 in | 125 |
| Total Capacity to Deer Island | | 913 |
| South Metropolitan System | | |
| High Level Sewer | 11ft-3in x 12ft-6in (maximum) | 360* |

*Unsurcharge capacity with free discharge at Nut Island.

Neck pumping stations. The cross sectional size of the sewer ranges from 8 feet-3 inches by 9 feet-6 inches in the upstream reaches, to 11 feet-3 inches by 12 feet-6 inches at the entrance to the treatment plant. The average slope is approximately 1 foot per 3,370 feet, with the invert of the sewer dropping a total of 24 feet from Parker Hill to the plant. The HLS was generally constructed of either brick or concrete in the excavated sections, and was tunneled in some sections, depending on the depth and soil conditions. The capacity of the High Level Sewer was taken to be 310 mgd from the Site Options Study. Future capacity has been evaluated based on recent modeling and flow measurements and established at 360 mgd with free discharge at Nut Island.

Main components of the South Metropolitan Systems are shown schematically in Figure 5.1.1-2.

### 5.1.2 NORTH SYSTEM HEADWORKS FACILITIES

The North System includes four headworks facilities at Chelsea Creek, Ward Street, Columbus Park and the Winthrop Terminal which are described below.

#### Chelsea Creek Headworks

The Chelsea Creek Headworks was placed in operation in 1968 to provide preliminary treatment, consisting of screening and grit removal, to a portion of the flow being treated at the Deer Island Wastewater Treatment Plant.

Wastewater flows through this facility by gravity and is discharged to the North Metropolitan Relief tunnel through the 10-foot-diameter vertical shaft No. 2 which extends approximately 300 feet below grade. The 10-foot-diameter North Metropolitan Relief Tunnel, 20,800 feet long, conveys the wastewater under Boston Harbor to Shaft No. 1 and the main pumping station intake at the Deer Island Treatment Plant.

The headworks superstructure is constructed of a brick, block, and metal siding. The concrete headworks also have a substructure which extends approximately 40 feet below grade and contains four parallel treatment channels. Each channel at this headworks, as well as at the other existing remote headworks, is provided with the following equipment:

- o Inlet and outlet sluice gates
- o Mechanically cleaned fine screens
- o Mechanically cleaned grit settling basins
- o Parshall flume for velocity control and for flow measurement.

Each treatment channel is rated at 117 mgd peak capacity. The headworks capacity of 350 mgd allows for one treatment channel to be held in reserve. Pneumatic ejectors transport the screening and grit to above ground storage hoppers. Periodically, this material is discharged to trucks for disposal.

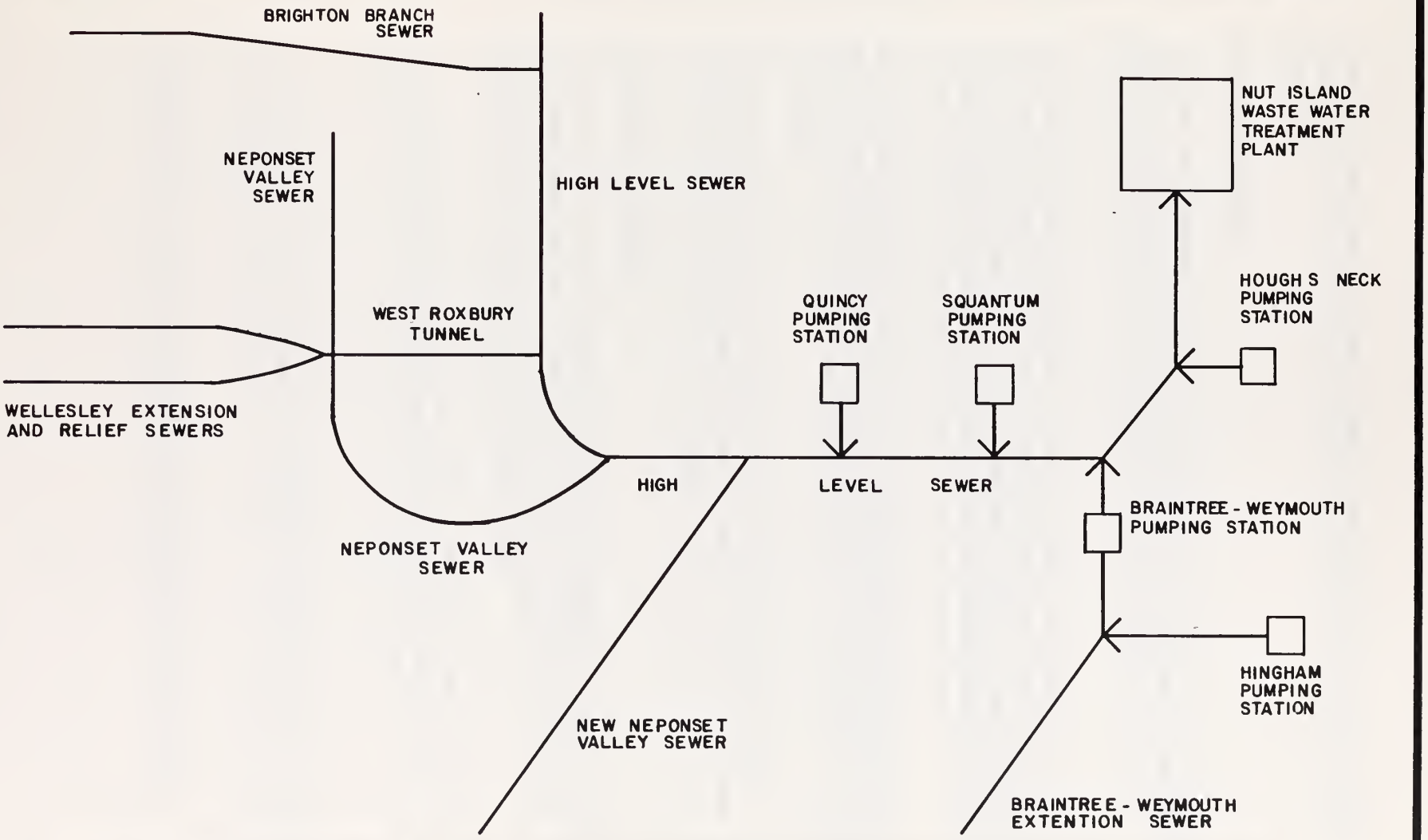


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FIGURE 5.1.1-2
SOUTH COLLECTION SYSTEM SCHEMATIC

Fast-track improvements will include installation of new climber-type mechanically cleaned screens, and grit collection equipment, as well as screening and grit handling and transport equipment.

Ward Street Headworks

The Ward Street Headworks is similar in most respects to the Chelsea Creek and Columbus Park facilities. This remote headworks, located in Roxbury Crossing, has been in operation since 1968, providing preliminary treatment consisting of screening and grit removal, to the wastewater.

Flow through the Ward Street facility is by gravity. Effluent is discharged to a 10 ft diameter vertical Shaft A, which extends some 300 feet below grade to the Boston Main Drainage tunnel. The Main Drainage Tunnel begins at the base of Shaft A, runs approximately 13,700 feet to Shaft B serving the Columbus Park headworks, and then proceeds 23,800 feet under Boston Harbor to Shaft C at the Deer Island Treatment Plant main pumping station.

The Ward Street Headworks consists of a brick and block multi-level superstructure and a reinforced concrete substructure which extends approximately 40 feet below grade. Within the substructure are four 85.3 mgd capacity channels, any three of which provide the rated capacity of 256 mgd.

Pneumatic ejectors transport the screenings and grit to aboveground storage hoppers. Periodically, this material is discharged to trucks for disposal. Fast-track improvements will be the same as those described for Chelsea Creek.

Columbus Park Headworks

Except for size and processing capacity the Columbus Park Headworks is similar in most respects to the other remote headworks. This facility, located in South Boston, went into operation in 1968 to provide preliminary treatment consisting of screening and grit removal, to the wastewater prior to discharge to the Main Drainage Tunnel.

Flow through the headworks is by gravity. Effluent is discharged to vertical Shaft B which extends approximately 300 feet below ground to the Boston Main Drainage Tunnel. The upstream segment of the tunnel is 10 ft in diameter and the downstream segment in 11 ft - 6 in. in diameter.

The headworks consists of a brick, block, and precast concrete multi-level superstructure and a reinforced concrete substructure extending approximately 30 feet below grade. Within the substructure are four treatment channels. Each channel is rated at 61 mgd and the headworks is rated at 182 mgd.

Pneumatic ejectors transport the screening and grit to aboveground storage hoppers. Periodically, this material is discharged to trucks for disposal.

Fast-Track improvements are the same as those described for other headworks.

Winthrop Terminal

The Winthrop Terminal facility, located at the Deer Island Treatment Plant, is situated between the existing administrative building and the primary clarifiers. The facility houses pumping equipment for flows arriving at Deer Island via the North Metropolitan Trunk Sewer and headworks facilities which provide preliminary treatment consisting of screening and grit removal. The North Metropolitan Trunk Sewer has a peak capacity of 125 mgd. The Winthrop Terminal was designed to screen and pump this entire flow and to provide grit removal for up to 60 mgd. Flows receiving grit removal are mixed with discharge from the Deer Island Main

Pumping Station for treatment at the Deer Island Treatment Plant. Flows in excess of the capacity of the grit system are pumped directly to the Deer Island bypass for discharge to the plant outfall system.

Blowers, which provide air to the influent channels of the Deer Island primary sedimentation tanks, are housed within the Winthrop Terminal building.

Influent flow to the facility is split to three screening channels. Normally, one channel is in service at a time. During wet weather, high flow events, all three channels are put into operation.

Screened wastewater flows by gravity to two wet wells. The wells are interconnected with a remote controlled sluice gate. The middle screening channel has the capability of discharging to either wet well. From the wet wells, a bank of six centrifugal pumps lift wastewater to the effluent channel. Four of the pumps are electric motor-driven and rated at 15 mgd each. The two remaining pumps are diesel engine-driven and are rated at 30 to 60 mgd each, depending upon whether they are discharging to the effluent channel or the Deer Island Plant bypass line. From the effluent channel, flow passes through a parshall flume to two aerated grit chambers. The maximum flow capacity of the grit chambers is 30 mgd each. Effluent from the aerated grit tanks discharges to a 54 in pipe. This flow is then mixed with the discharge from the Deer Island Main Pumping Station and enters the primary sedimentation tanks.

MWRA's recommended fast-track improvements include replacement of existing coarse and medium bar screens with 7/8-in-spaced climber-type bar screens, overhaul of electric pump motors, refit of pump impellers, construction of a grit bypass system, new instrumentation and controls, hvac and odor control equipment. The existing bypass will be replaced by the construction of a 4 ft by 4 ft conduit between the pump station discharge flume and the deer island main pumping station effluent conduit.

The bar screens were sized for two screens to handle the 125 mgd flow, and the third screen is to be either held in reserve or out of service. After the fast-track improvements the Winthrop Terminal Pumping Station will have the following capacity:

| No. Pumps | Pump Rated Capacity mgd |
|---|---|
| 2 | 37 |
| 4 | 22 |

In order to handle the 125 mgd design flow, at least five of the six pumps will have to be in operation, with only one pump on standby.

### 5.1.3 DEER ISLAND TREATMENT PLANT

The Deer Island Wastewater Treatment Plant, originally completed in 1968, provides primary treatment to flows from the North Metropolitan Sewerage System. The plant was designed to treat an average flow of 343 mgd and a peak flow of 848 mgd. Treatment consists of preaeration, primary sedimentation, and disinfection.

Flows from the Boston Main Drainage and North Metropolitan Relief tunnels are pumped to the treatment plant at the Deer Island Main Pumping Station. Flows from the North Metropolitan trunk sewer are discharged to the plant via the Winthrop Terminal. Mixed flows are discharged to two preaeration channels. Primary treatment is provided by eight sedimentation tanks. effluent from the primary tanks is chlorinated and discharged to the harbor through a series of outfalls.

Primary sludge, grease, and scum is collected, thickened, and pumped to anaerobic digesters. Digested sludge, and bypass flows from the winthrop terminal, are mixed with the primary effluent prior to discharge to the harbor.

Major Components

The major components of the original Deer Island Wastewater Treatment Plant include the following:

- Nine main sewage pumps, 90 mgd each
- Two preaeration channels, 400 ft x 20 ft
- Eight primary sedimentation tanks, 245 ft x 100 ft
- Four raw sludge pumping stations with three pumps in each
- Four anaerobic digester tanks
- Five diesel generating sets, 700kw each
- Five chlorinators, 8,000 lb/day each
- Five outfalls to the harbor

Schematics of the Deer Island Wastewater Treatment plant showing the flow pattern, the number and arrangement of treatment units, and the outfall system are shown in Figure 5.1.3-1.

Main Pumping Station

The Deer Island Treatment Plant Main Pumping Station consists of nine vertical shaft, mixed flow, bottom suction sewage pumps. Each pump is rated for 90 mgd at 105 ft tdh and 400 rpm. The pumps were designed to be operated over a speed range of 250 to 400 rpm. An empty bay is provided in the pumphouse for a tenth pump.

The pumps are driven through 90 ft long shafts. Eight pumps are driven by diesel engines, and one pump is driven by a 2,000 hp synchronous electric motor with a variable speed magnetic coupling.

The diesels are 12 cylinder, radial type, vertical shaft engines furnished by the Nordberg manufacturing Company of Milwaukee, WI and St. Louis, MO.

Each pump suction piping connects to a bifurcation which is piped to both the Boston Main Drainage and North Metropolitan Relief Tunnels. Each leg of the bifurcation contains a 60 in diameter butterfly valve and a 60 in diameter rubber expansion joint. The butterfly valves are pneumatically operated with a manual handwheel override. There are no valves on the pump discharge.

The pumps lift the wastewater through a 60-in diameter pipe discharge which includes a venturi meter to measure flow. Each pump discharge line is arranged as a siphon and each siphon is equipped with vacuum priming and vacuum breaking piping and valves. Two vacuum pumps are provided to prime the nine siphons. The pumps discharge to one of two headers which join in a common conduit to the primary plant.

The Deer Island Main Pumping Station receives wastewater from the three remote headworks and lifts it to the head end of the treatment plant. The pumping rate is adjusted to maintain a constant water level at the headworks. Pump start up and shutdown, and butterfly valve opening and closing, are done at the Main Pumping Station control room. Adjustment of pump speed is done either manually at the pump driver or automatically in the control room. Pump suction valving is such that any pump may take suction from either tunnel. The original nickel-iron alloy impellers have been replaced. Seven impellers are now stainless steel and two are nickel-iron alloy.

The pump drivers are arranged in two rows (odd numbers to the west, even numbers to the east) at floor elevation 130 ft, the operating floor of the Main Pumping Station. The original plant design includes space allocation for a future pump (No. 10).

Based on discussions with plant operators and a review of the Deer Island Facilities Plan - Volume 1 Fast Track Improvement document, the unreliability and high maintenance associated with the Nordberg diesels constitute the most serious problem in the operation of the pump station/powerhouse facilities. These particular engines have been out of production since 1965, and Nordberg Mfg. Co. is no longer in business. Because of this, the costs of

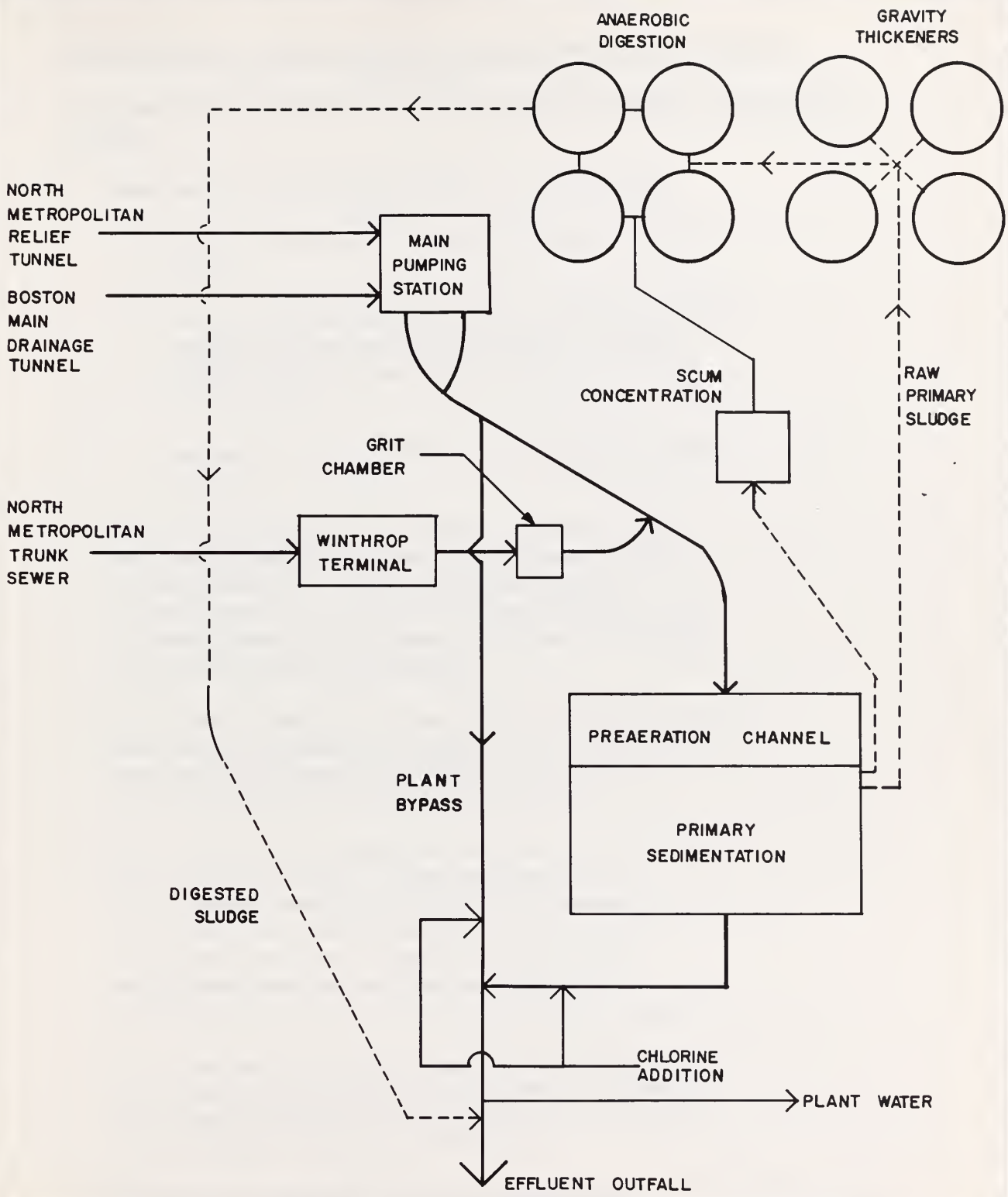


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**FIGURE 5.1.3-1**
**DEER ISLAND**
**WASTEWATER TREATMENT PLANT**
**SCHEMATIC - EXISTING CONDITIONS**

replacement parts is extremely expensive and some parts are virtually unobtainable.

The proposed fast track improvements to the Deer Island Main Pumping Station include the following:

- Empty bay (No. 10) and pump bays (No. 2, 4, 6, and 8) provide:
  - Five new vertical centrifugal pumps, each rated 90 mgd at 105 ft tdh.
  - Four new 2,000 hp synchronous motors, variable speed magnetic coupling drives, and reduced voltage starters. One existing 2,000 hp electric motor and variable speed drive (No. 8) will remain in service.
  - One new 8 in. diameter solid steel shaft, bearings and couplings (No. 10).
- Four existing shafts (No. 2, 4, 6, and 8) are proposed to remain in service and be modified to accept new 2,000 hp motors. Condition of existing shafts will be verified by non-destructive testing. Existing bearings will be evaluated and replaced as required. Method of lubricating bearings will be improved. New spacer couplings will be provided to facilitate pump maintenance.
- Existing and new electric driven pumps will be controlled from a new pump control room to be located on the mezzanine level. New 4,160 V motor starters and variable speed drive controllers will be installed in a new electrical room also located at the mezzanine level.
- Five existing Nordberg engines, shafts and pumps (no. 1, 3, 5, 7, and 9) will remain in service. These pumps will continue to be controlled pneumatically from a local panel at each engine. Remote auto-manual, speed, status and alarm conditions will be relocated to a new pump control room by installing P/I converters at the existing graphic panel and transmitting electronic signals to the new control room. The existing control room will be abandoned.
- The existing pneumatic analog pump controller will be replaced with a new electronic analog controller (microprocessor) to accommodate the new electric motor-driven pumps and the new electronic signals from the existing Nordberg engine driven pumps.
- The pump suction piping for the five electric motor driven pumps (No. 2, 4, 6, 8, and 10) will be revised to include a new

60-in knife gate valve downstream from each butterfly valve (one valve on each leg of the wye). They will be installed without dewatering the tunnel system and will protect the pump station against butterfly valve failure in the open position.

- A new 60-in butterfly valve will be installed in the existing discharge piping of pump No. 2, 4, 6, and 8.

- New 60-in steel discharge piping, flow meter and butterfly valve will be installed for the new pump No. 10 (empty bay).

- The new discharge valves will allow the pumps to be started against a closed discharge valve instead of a closed suction valve, eliminating the cavitation condition that occurs at present. The new discharge valve will be closed just prior to normal shutdown of the pump.

Power And Utilities

The power station generating capability currently consists of five diesel generator sets provided by the Enterprise Engine & Machinery Company of Oakland, CA, which were installed with the original plant in 1968. The diesels are eight cylinder, in-line type engines that can be operated on digester gas or diesel fuel. The generators are rated at 700 kw each and were furnished by Allis Chalmers.

The five diesel generators are arranged side by side and numbered sequentially from north to south, at the operating floor level (elevation 130 ft). The diesel engines are reliable and have good availability.

The proposed fast track improvements to the generating facilities including the following:

- The five existing 700 kw diesels will be rehabilitated (under Power Distribution Rehab Contract) and will remain in service.

- Install two new 6,000 kw dual fuel diesel engine/generator sets in a new building addition. New diesel engines will be started/ stopped locally at each diesel and controlled from a new control panel in the switchgear room. Alarm and status indicators will be located at diesels, in switch-gear room, and in the new Pump Control Room.

- A new power distribution arrangement will allow the diesels to operate in parallel or be separated (5 existing diesels on one bus

and 2 new diesels on another bus). In general, the two new diesels will power the electric-driven raw sewage pumps and the existing diesels will power all other plant loads.

- The existing once-through cooling water will be replaced with a closed loop water system with heat rejection through cooling towers. The new system will recover heat from the jacket water of the Enterprise engines, the new 6,000 kw engines and the remaining Nordberg engines. The heated closed loop water will be routed through heat exchangers to provide heat to the sludge heating water, which in turn will be routed through heat exchangers to heat sludge at the digesters.

Treatment Facilities

Flows from the Main Pump Station and the Winthrop Terminal are discharged to two preaeration channels which also serve as distribution channels to the eight primary sedimentation tanks.

Wastewater is conveyed from the Main Pumping Station and Winthrop Terminal to the primaries via a 20-ft-wide by 14-ft-deep concrete channel which flows full. This channel splits into two 10-ft-wide by 14-ft-deep aerated channels, each of which feeds one-half of the primary tanks. Either of these channels can be isolated from the main influent channel by means of large motor operated sluice gates.

The two aerated channels are furnished with one stationary air diffuser and 22 swing arm diffusers each. Positive displacement compressors for these diffusers are located in the Winthrop Terminal Headworks.

From the aerated channels, wastewater is fed into each primary sedimentation tank through ten manually operated 24-inch by 42-inch downward operating sluice gates. Each primary sedimentation tank is approximately 100 ft wide by 240 ft long with an average side water depth of 11.35 ft. The tanks are equipped with traveling bridge collectors and chain and flight cross-collectors. Each tank has approximately 100 ft of straight-edge weir at its effluent end over which settled wastewater falls into the effluent channel.

Traveling bridge collectors push scum to the effluent end of the tanks where the bridge pauses for a period of time while a reciprocating scum collector travels back and forth across the width of the tank and pushes scum over a V-notch weir on either side of the tank. Scum from all eight tanks flows to a central sump located between Tank Nos. 4 and 5 from where it is pumped to scum thickeners. Sludge is pushed to the influent end of the primary tanks to the cross-collector hopper where it is moved to one end by a chain and flight collector. Sludge is withdrawn from the hopper by sludge pumps, three of which are provided for each pair of primary tanks.

The westernmost aerated influent channel of the settling tanks has substantial accumulations of grit, nearly reaching the water surface at the downstream end at the time of the on-site

inspections during August and September 1986. This may be caused by the poor condition of the swing diffusers which have never been replaced, higher concentrations of grit to the westernmost channels due to hydraulic anomalies, lack of sufficient mixing air, poor upstream grit removal, or all of the above.

The swing diffusers are in poor condition. Those in the easternmost channel were replaced several years ago and are operable but have serious corrosion problems, with holes completely through the pipe in some places. Those in the westernmost channel are original equipment, and are in very poor condition. These diffusers create little visible turbulence and are covered with grit. Plug valves for the diffusers are rusted and some are stuck in the open position.

The inlet sluice gates and inflet baffles to the primary tanks are in poor condition. The sluice gates are opened and closed manually or by portable electric operators. The portable operator sometimes causes the gates to be opened or closed too far, creating high stresses on the gate itself or on the anchoring system. Half of the 80 gates show evidence of these problems. Five gates cannot be fully closed, making dewatering difficult. Maintenance of the sluice gates is hampered by their location on the aeration channel side of the wall (seating head). This means that for adjustments to be made on any one gate, one-half of the plant's primary treatment capacity must be removed from service. Each sluice gate has a steel inlet baffle just downstream on it, inside the tank. These baffles are severely corroded and some are completely missing.

Dewatered basins have reportedly experienced leakage through several expansion joints from full basins into emptied basins. It is not known at this time how many of the basins are affected or to what degree of severity the leakage occurs.

The water level in the effluent channel from the primary tanks was originally maintained by a tainter gate in order to provide chlorine contact time. A few years after start of operation, this gate became inoperable. As a result, the water level in the channel is now below the elevation of the scum sump float valve and it is inoperable.

Currently, one scum pump is continuously operating with the scum collection V-notches set to match this flow as closely as possible. However, the pump normally pumps slightly more than this, and lowers the water level in the sump until the pump begins taking air.

The scum collection system has proven to be a problem, particularly in winter months. Scum begins freezing at the V-notch weirs and if not broken up and manually pushed over the weir, the buildup begins extending out into the tank. This situation is difficult to overcome because the scum collecting mechanism must be started manually and thus does not clean the surface every time the traveling bridge delivers a load of scum. Further, the remote and exposed location of the scum collectors does not encourage manual attention, particularly during severe weather when attention is most required. In the past, this problem has often proven disastrous, bending scum collectors on the traveling bridges and sometimes becoming so severe that tanks have had to be removed from service.

The following problems have been reported with the operation of the sludge pumping station:

1. All of the Homestead crossover valves on the primary sludge pump intakes are frozen in either open or shut positions. Consequently, the middle pump at each station is available as standby for only one of the two tanks.

2. All of the sump pumps at the primary sludge pumping stations have either been removed or are inoperable. None of the pumps has worked for about 10 years. As a result, the crossover valves are usually submerged.

3. There are no check valves on the primary sludge pump discharge pipe.

4. The water seal glands and piping are corroded and in poor condition for all 12 primary sludge pumps.

5. For most of the primary sludge pumps, the coupling guard protection is gone.

6. Most of the primary sludge pump pressure gauges are rusted out, and none work.

The electrical power system and controls for many of the traveling bridge collectors are in poor condition. Much of the electrical conduit is badly rusted and most of the timers for short-and medium-pass bridge travel modes are inoperable or removed. Some chain and sprocket guards for the traveling bridges are badly rusted.

Turnbuckles and cables used for raising and lowering the sludge and scum collector blades are a constant problem because of corrosion and breaking. Cable and turnbuckles often break. When this occurs, the sludge scraper falls to the bottom of the tank and often becomes bent.

Originally, the traveling bridges were supplied power by bus bar. This caused severe problems during cold or wet weather, and the system was replaced with festooned cable. The cable has proven fairly reliable, except that occasionally a cable ring breaks and drops the cable to the rail where it is cut by the bridge wheel, putting the unit out of service.

The proposed fast-track improvements program at the Deer Island Primary Treatment Facilities includes the following components:

- Replacement of all 80 influent sluice gates and baffles to the primary tanks
- Replacement of the sludge collectors and travelling bridge drives and hoists
- Rehabilitation of the traveling bridges
- Installation of new scum collection and pumping systems.

Disinfection is currently provided to the plant effluent using gaseous chlorine. Chlorine can also be used for pre-chlorination just prior to the flow's entering the primary tank preaeration channels; for pre-chlorination of influent flows to the Winthrop Terminal Headworks; and for disinfection of non-potable plant water.

Chlorine is delivered to the Deer Island Plant in 16-ton tanker trucks which are stored in the chlorine storage room. Each chlorine tanker truck is located on a separate weigh scale. Chlorine is withdrawn from the tankers and piped to a separate chlorine feed room which houses seven evaporators and seven chlorinators. Injectors are operated by non-potable plant process water and booster pumps. The injectors pull chlorine from the chlorinators under vacuum and inject it at the various application points.

The existing chlorination system is at the end of its useful life. The MWRA has determined that sodium hypochlorite, rather than gaseous chlorine will be used for disinfection. The MWRA is currently in the process of designing the sodium hypochlorite system.

The Deer Island Fast Track Improvements program is proceeding, making those improvements to the existing gaseous system necessary for plant safety.

Outfalls

There are five outfalls from Deer Island, designated by the EPA as 001 through 005. Construction dates back to the 1890s, with the newest outfall having been constructed in 1964.

Outfall 002 is the oldest, and was constructed in three phases. The first phase was built in 1891. This consists of the portion on Deer Island, a 63-1/2 in by 60-in wide, egg-shaped, brick-lined, concrete tunnel leading to a shoreline outlet. In 1895 the second phase was built. This extended the outfall about one quarter of a mile offshore in a southerly direction, into President Roads channel. Approximately one third of the length of the conduit installed in this phase consists of 63-1/2-in-diameter brick-lined tunnel formed in concrete. The remainder is a 63-1/2-in-diameter pipe built up from wood stave, with a brick lining set in Portland cement. The pipe is anchored to pile bents, buried, and protected with rip-rap. The outlet is an upturn which is flush with the harbor bottom.

The third and final phase of Outfall 002 was installed in 1917. It consists of an approximately 300-ft extension of 60-in-diameter cast iron pipe. The first 200 ft are buried and protected with rip-rap. A partially buried diffuser makes up the last 100 ft. Thirteen elliptically-shaped ports were cast into the top of the iron pipe, and the end has a 48-in-diameter opening. When this extension was installed, the vertical outlet of the previous 1895 phase was capped off.

Outfall 003 was originally constructed as a bypass to be used during the installation of the diffuser, or third phase, extension of Outfall 002. It is approximately 800 ft long. About half of this outfall is on the island and consists of 78-in-diameter formed-in-place concrete pipe. The offshore portion extends southeast to a vertical outlet about one-tenth of a mile

from the island. It is constructed of 60-in-diameter cast iron pipe buried and protected with rip-rap. The outlet is flush with the harbor bottom.

Outfall 001 was installed in 1964 as a part of the primary treatment plant project constructed on the island for the North Metropolitan Sewerage System. It consists of a buried 120-in-diameter reinforced concrete pipe protected with rip-rap. The outfall extends about one-half mile offshore to the south-southeast into President Roads channel. It terminates in a diffuser approximately 250 ft long.

The diffuser nozzles are 20-in-diameter and are arranged in pairs angled at 45° to the vertical. The pairs are spaced on 8-ft centers over the length of the diffuser, which steps down in size from 120-in-diameter to 108-in-diameter to 60-in-diameter. A short endpiece consists of three staggered nozzles with a 30-in-diameter upturned opening at the end. There are a total of 58 nozzle ports. The diffuser section is buried up to the nozzles and protected with rip-rap.

Outfalls 004 and 005 are relief bypasses installed for use during the construction of Outfall 001. They consist of buried, 108-in-diameter reinforced concrete pipe. Outfall 004 extends offshore a few hundred feet from its connection to the pipe leading to Outfall 001, in a southerly direction. The outlet is simply the open end of the pipe. The area over the pipe and around the outlet is protected with rip-rap. Outfall 005 has a shoreline outlet connecting to the pipe leading to Outfall 001, upstream of Outfall 004. It discharges on the west shore of the island a few hundred feet north of Outfall 004. The outlet is similar to that of 004. Outfalls 003 and 004 are currently used when the capacity of Outfalls 001 and 002 is exceeded. Outfall 005 is not used for excess flow, but only if repair work is being done on the other outfalls.

There are also four outfalls from Nut Island, designated by the EPA as 101 through 104, and a sludge discharge line designated as 105. Construction dates back to the turn of the century.

Outfalls 101 and 102 were built in 1904 as part of the screening and sandcatcher facility. They each extend in a northerly direction approximately one mile offshore into the Nantasket Roads channel area of the harbor. They are constructed of 60-in-diameter cast iron pipe. The pipe is buried and protected with rip-rap. The outlets were originally simple single upturns, flush with the harbor bottom.

Outfall 103 was built in 1914 to add capacity to the 1904 sandcatcher facility. It extends approximately one-quarter of a mile offshore into Quincy Bay, paralleling the original outfalls. It consists of a buried 60-in-diameter cast iron pipe protected with rip-rap. The outlet, like those of 101 and 102, is a simple upturn, flush with the harbor bottom.

In the period between 1946 and 1952, a primary treatment facility was added to Nut Island. Along with it came the construction of two new outfalls, 104 and 105, and modification of two of the existing outfalls.

The outlets to outfalls 101 and 102 were capped to form hexagonal side discharges. It is

presumed that this was done to improve mixing of the effluent with the ambient harbor water.

Outfall 104 extends east of Nut Island, about one-tenth of a mile into Hingham Bay, and has a single horizontal outlet. It is a buried 60-in-diameter reinforced concrete pipe intended to be an emergency bypass to carry the overflow when the capacity of the original three outfalls is exceeded.

Discharge 105 is a 12-in-diameter cast iron sludge line. It extends about 4 miles in a northerly direction to a point near the north end of Long Island in the President Roads channel area of the harbor. It has a specially-shaped slotted outlet designed to promote mixing.

Outfalls 101 and 102 underwent a major cleaning operation in 1985-86 to restore their capacity. Prior to this, the short outfalls 103 and 104 were in use for longer periods than originally intended because of the deteriorated capacity of outfalls 101 and 102. The increased use of 103 and 104 was a concern because of their closer proximity to Nut Island and the beaches in the City of Quincy.

### 5.1.4 NUT ISLAND TREATMENT PLANT

The Nut Island Wastewater Treatment Plan, originally completed in 1952, serves the South Metropolitan Sewerage System. Collection of wastewater from communities served by the system is routed through the High Level Sewer to the treatment plant. Treatment provided at the plant consists of screening, grit removal, preaeration, primary sedimentation, and disinfection. Plant effluent is discharged to the harbor. A schematic of the plant is presented in Figure 5.1.4-1.

Flow enters the facility at the headworks where it is channeled to two cantenary-type bar screens with 7/8-in bar openings that are operated by timers. Large solids and trash are caught on the screens, raked to an ejector pot and ejected by air to a receiving container.

From the screenings area, wastewater is diverted to six grit chambers. Grit it collected by a chain and bucket mechanism, scraping the floor of the chamber and depositing the grit on a conveyor for transport to the ejector pots. Once a sufficient quantity of grit is collected in the pot, air is used to eject the material to a receiving container. The screenings and grit removed from the wastewater are deposited into a common container. A private contractor hauls the material off-site on a regular basis.

The screened, degritted wastewater flows to the main wet well, from which it is pumped to the preaeration and primary sedimentation basins.

Pumping of the plant flow is provided by four main sewage pumps rated at 83 mgd each. Pumped sewage is metered through a venturi meter and discharged to five preaeration basins. At the preaeration basins, air is injected into the waste stream by two 5000 cfm blowers. Primary sedimentation is provided by six sedimentation basins. Sludge and grease are anaerobically digested in four digesters and routinely withdrawn, disinfected and discharged through the sludge outfall to the Harbor off Long Island.

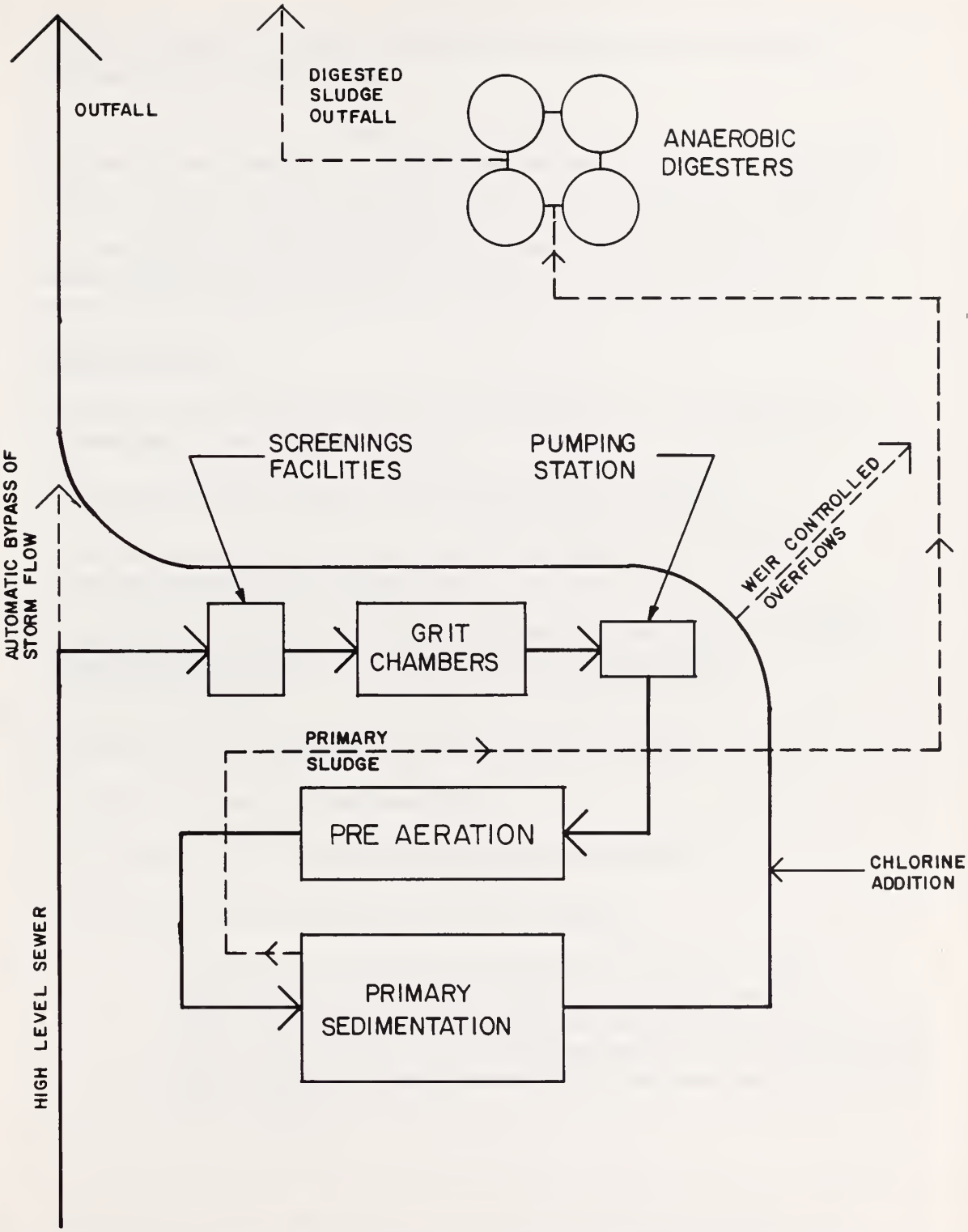


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**FIGURE 5.1.4-1**
**NUT ISLAND**
**WASTEWATER TREATMENT PLANT**
**SCHEMATIC**

Chlorine for disinfection is applied to sedimentation basin effluent prior to its discharge to the harbor through two of five outfalls.

The High Level Sewer has a maximum capacity of slightly greater than 300 mgd. A portion of these peak flows are bypassed prior to treatment dependent upon the number of treatment units available at the plant at any one time. At the entrance of the High Level Sewer to the plant, there is an emergency spillway at Elevation 120.30. Overflows to this spillway occur when flow to the plant reaches about 280 mgd with both bar screens available. The High Level Sewer capacity could be increased if existing hydraulic limitations in the Nut Island Plant were removed (see Section 6.2).

Recent Improvements

Since 1984, a number of improvements have been implemented at the Nut Island Wastewater Treatment Plant. These improvements include:

- Addition of an influent flow meter (sonic type) to the High Level Sewer.
- Installation of a new ventilation system, odor control equipment, and explosion-proof electrical components, all in to the grit room.
- Abandonment of comminutors immediately downstream of the grit chambers. The effluent channels from the grit tanks were rebuilt for smoother transition and for a decrease in headloss.
- Rebuilding of one engine generator and one preaeration blower motor.
- Installation of off-site, purchased power service.
- Replacement of most of the air header to the preaeration tanks with new line.
- Construction of improvements to the primary tanks, including:

  Rebuilding tanks structurally, repairing columns and supports for sludge collectors. Repairing leaks, leveling tank floors. Replacing all weirs and replacing sludge collection equipment. Replacement of outside sludge piping from the primary sludge pumps to the anaerobic digesters with 250 lb, glass-lined ductile iron piping. Addition of a programmable controller for automated operation of the sluice gate on Outfall 103.

## 5.2 EXISTING ENVIRONMENT

### 5.2.1 PHYSIOGRAPHY AND GEOLOGY

#### Deer Island

Physiography

The dominant topographic and geologic feature on Deer Island is the central drumlin which crests at approximately elev.210. The major axis of the drumlin is oriented east-west and extends approximately 2,000 ft with a minor axis of about 1,000 ft. Another smaller, partially eroded drumlin is located at the north shore of the island and stands at a maximum elev.170. The small drumlin is believed to have been just as large as, and oriented roughly parallel to, the central drumlin; however, due to significant erosion along the seaward side, the major axis of this drumlin is currently oriented northwesterly and extends approximately 1,400 ft with a minor axis of about 400 ft. The remnant of a third drumlin is barely perceptible at the southernmost tip of the island. This feature shows little topographic expression and no longer presents a distinctive form.

The processes of weathering and erosion have significantly modified the structure of the island. It was during a severe hurricane in 1936 that the channelway known as Shirley Gut was closed off by wind and current action. At this time Deer Island became, in actuality, a peninsula of the mainland. Wave action has severely affected the northern and eastern shorelines to the point that a seawall was erected to suppress the degradation. Similarly, tidal currents have remolded and redeposited glacial sediments in the formation of a sand and gravel extension of the island southward toward President Roads.

Man-made features have necessarily altered the contours of the island over the years. Construction of the existing sewage treatment facility required removal of part of the central drumlin along the northwest flank. In addition, a plant water reservoir was constructed at the crest of this drumlin. A swamp/tidal marsh area north of the central drumlin was backfilled to facilitate construction of the existing treatment plant. Fill materials have also been placed along roadways, particularly along the western shore of Deer Island. Excavation spoil or "tunnel muck" from previous shaft excavations has also been placed along an area of the western shoreline near the existing treatment facility. Approximately 600 ft south of the central drumlin, near the eastern shore of the island, stands a man-made earthen bunker formerly used by the military as part of the coastal defense system. This structure is elongate in a north-south direction extending about 700 ft with a minor axis of approximately 250 ft. The maximum relief is about 40 ft above the surrounding topography.

Geology

The Deer Island drumlins were deposited by the retreating glacier onto a very compact unit of clay, sand, gravel, and boulders, which in turn overlies an irregular bedrock surface. Flanking the slopes of the drumlins are marine deposits and stratified glacial drift. These

consist chiefly of a marine clay overlain by sand and gravel outwash containing occasional lenses of glacial till. The uppermost unit consists of more recent deposits of silty fine-to-medium sand with some traces of organic material. The bedrock is predominantly argillite and is persistent throughout the area of the island.

Surficial Deposits. A dense to very dense mixture of clay, silt, sand, gravel and boulders (glacial till) covers the bedrock surface and comprises the drumlins on Deer Island. Till thicknesses approaching 200 ft have been noted in the area of the central drumlins. As is typical of glacial till deposits, the proportion of this coarse- to fine-grained material is highly variable. However, isolated pockets and lenses of near-homogeneous fine materials occur throughout the tills. The remaining land area soils, adjacent to and between the drumlin exposures, consist of a gray silty clay that are overlain by fill or sand and gravel outwash deposits. The clays vary in thickness, reaching a maximum thickness of 50 ft, whereas the sands and gravels generally range from 0 to 20 ft in thickness.

Organic silts, peat and muck have been observed in borings in low lying areas between the drumlins. This occurrence would be indicative of the formation of a tidal marsh or backswamp during a period of lower sea level. A subsequent rise in sea level permitted deposition of the fine sand and gravel associated with the more recent beach deposits.

Bedrock Geology. Like much of the Boston Harbor area, Deer Island is underlain by slightly metamorphosed and often complexly folded and faulted argillite. This is generally very thinly bedded, laminated to occasionally non-bedded fine grained rock characterized as the Cambridge Formation of the Boston Basin Group. Bedding or laminations are quite prominent as alternating light and dark gray bands which generally dip 25° to 50° from the horizontal. Fractures (partings) in the rock are generally observed parallel to the laminations. The rock is well indurated and, with few exceptions, is moderately-hard to hard. Unconfined compressive strengths varied from less than 4000 psi to greater than 35,000 psi with average values of 15,000 - 20,000 psi. Based on borings and a seismic refraction survey, the topographic relief of the bedrock surface varied from approximately elev. +30 beneath the central drumlin to elev.-40 along the western side of the island.

Due to the complex sedimentary and structural historey of the harbor area, other rock types are often found interlayered with, faulted into, or intruded into the argillite. Other rock types associated with the Boston Basin Group include tuffs, sandstone, quartzite and conglomerates in addition to intrusions by dikes and sills of diabase, basalt and/or andesite. At Deer Island the only known occurrence of rock other than argillite is that of a basalt sill found at tunnel level near the vertical shaft to the Main Drainage Tunnel. However, this does not preclude the existence of other bedrock types on the island.

Nut Island

Nut Island is actually a small peninsula connected to the mainland by a man-made causeway. The present topography is quite flat with surface elevations along the peninsula varying between 125 ft and 130 ft. Man-made features dominate the area in the form of treatment facilities

extending from the north end to the south end of the island-mainland causeway. Stone riprap protects the entire peninsula perimeter from the effects of wave action.

Geology. Similar to many of the Boston Harbor inner islands, the general geologic profile at Nut Island consists of a variety of surficial deposits overlying glacial till which, in turn, overlies bedrock. The glacial till is associated with the partially eroded drumlin at the north end of the peninsula. The surficial deposits are post-glacial clays or organics, as well as extensive areas of fill.

Soils. The drumlin till consists of a dense to very dense homogeneous mixture of boulders, gravel, sand, silt, and clay. Till thicknesses exceeding 125 ft have been recorded at the north end of Nut Island. Marine clays up to 20-ft-thick have been found along the west and east flanks of the causeway. Minor thickness of organic soils overlie the clays in the east-central portion of the peninsula.

The connecting causeway was created by the placement of fill materials whose origin was most likely the drumlin till to the north. The fill is primarily a mixture of coarse materials with some silt and clay present.

Bedrock. As is the case with Deer Island, Nut Island is underlain by a thinly bedded, fine-grained bedrock characterized as Cambridge argillite. Bedding or laminations are common as alternating light and dark gray bands. Fractures are generally parallel to the laminations. The rock is well indurated and moderately hard to hard.

Due to the complex sedimentary and structural history, other rock types may be found interlayed with, faulted into, or intruded into the argillite. These rock types include conglomerates, diabase or basalt sills, and quartzite.

### 5.2.2 SURFACE AND GROUNDWATER HYDROLOGY

#### Surface Water

As described in section 5.2.1, the natural contours of Deer Island have been significantly altered over the years. There are no natural surface water bodies on Deer Island. Man-made surface water features consist of the existing primary treatment tanks and a three million gallon cooling water reservoir located at the top of the central drumlin. Rainfall runoff in the developed areas of the prison and the treatment plant is collected by roads/catch basins and drained to the harbor. Rainfall runoff in all other areas of Deer Island is discharged to the harbor via natural swales or drainage areas.

The wastewater treatment plant and Fort Dawes, located at the southern end of Deer Island, have created shoreline protection and alterations such as rip-rap, groins, seawalls, and piers. These shoreline alterations nearly encompass Deer Island.

The 100-year flood elevation is obtained from the Federal Emergency Management Agency. All other elevations are obtained from a study prepared for the City of Boston (CDM, 1967).

Comparison of these elevations with the MDC sewer datum (MDCSD) is as follows:

| | Elevation, ft, MDCSD | Elevation, ft, USGS |
|---|---|---|
| Flood tide of record | 115.7 | 10.1 |
| 100-year flood | 115.6 | 10.0 |
| Mean high water | 110.6 | 5.0 |
| Mean sea level | 105.6 | 0.0 |
| Mean low water | 101.1 | -4.5 |

Design flood level elevations used for the treatment plant facilities are described in Section 8.2.

Groundwater Hydrology

As indicated above, mean sea level at Deer Island is at 105.6 ft. In the low-lying areas adjacent to and between the drumlins of Deer Island, groundwater levels generally vary between elevation 108 to 114 ft, approximately 8 to 11 ft below ground surface. (Metcalf and Eddy, 1983; CDM, 1986).

At the central drumlin there appears to be a perched water table that generally follows the contour of the drumlin. Here the water table lies within a sandy, clayey, gravel (till) at depths varying between 10 to 30 ft below the ground surface. Near the crest of the drumlin the water table may be at an approximate elevation of 172 ft. Storage and recharge capacities are thought to be limited due to the dense and impervious nature of the till.

### 5.2.3 METEOROLOGY

The climate of the Deer Island area is best described using long-term representative meteorological data collected at the National Weather Service Office at Logan International Airport in Boston, Massachusetts. The airport is located approximately 1.2 miles west of Deer Island.

The climate of the region is continental; however, the Atlantic Ocean has a significant moderating effect. Sea breezes occur on hot spring and summer afternoons, displacing the warm, westerly airflow with a cool, moist east wind off the water. These breezes generally develop several hours after sunrise and persist for most of the afternoon. The region is situated near

42° N latitude, in the prevailing westerlies, and the weather undergoes alternating intrusions of tropical and polar air masses. In the early fall, hurricanes can bring destructive winds to the area. From late October to late April, major east coast storms bring significant rain and snow. During the warmer season, May through September, rainfall is mostly limited to showers and thunderstorms which accompany frontal passages. Thunderstorms occur on an average of 19 days during the year. On the average, precipitation occurs 1 out of 3 days throughout the year.

New England is affected by high and low pressure systems which originate from areas of North America that differ significantly in climate. The direction of air flow and duration of a particular air flow direction over New England depends on the track (relative to New England) and speed of these high and low pressure systems.

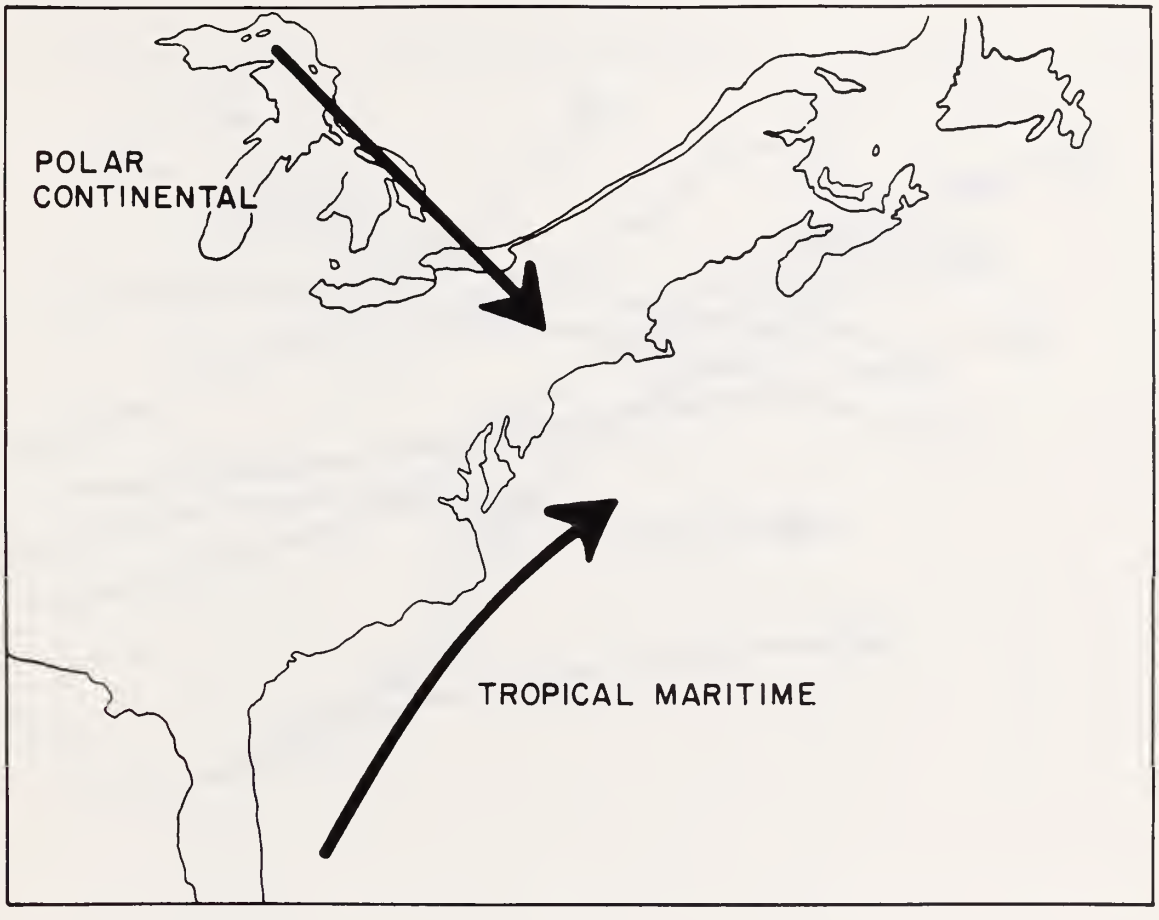
Two types of high pressure systems or air masses frequently affect New England: polar continental and tropical maritime. The general tracks of these two types of systems are shown in Figure 5.2.3-1. A polar continental high pressure system originates in the polar region of the North American continent. This type of system affects New England during all seasons and usually brings dry, abnormally cold air with partly cloudy sky conditions. The tropical maritime high-pressure system originates from the tropical region of the Atlantic Ocean and usually imports abnormally warm humid air to New England.

Low pressure systems which affect New England generally move from the west or the south, as shown in Figure 5.2.3-2. Winter low pressure systems are larger and more intense than summer systems and tend to track up the Atlantic seacoast. Flows off the ocean, affecting all of New England for extended periods of time, are usually the result of the counterclockwise flow around a low pressure system passing to the east of New England. Low pressure systems which originate in the center of the United States are usually drier and less intense than coastal low pressure systems.

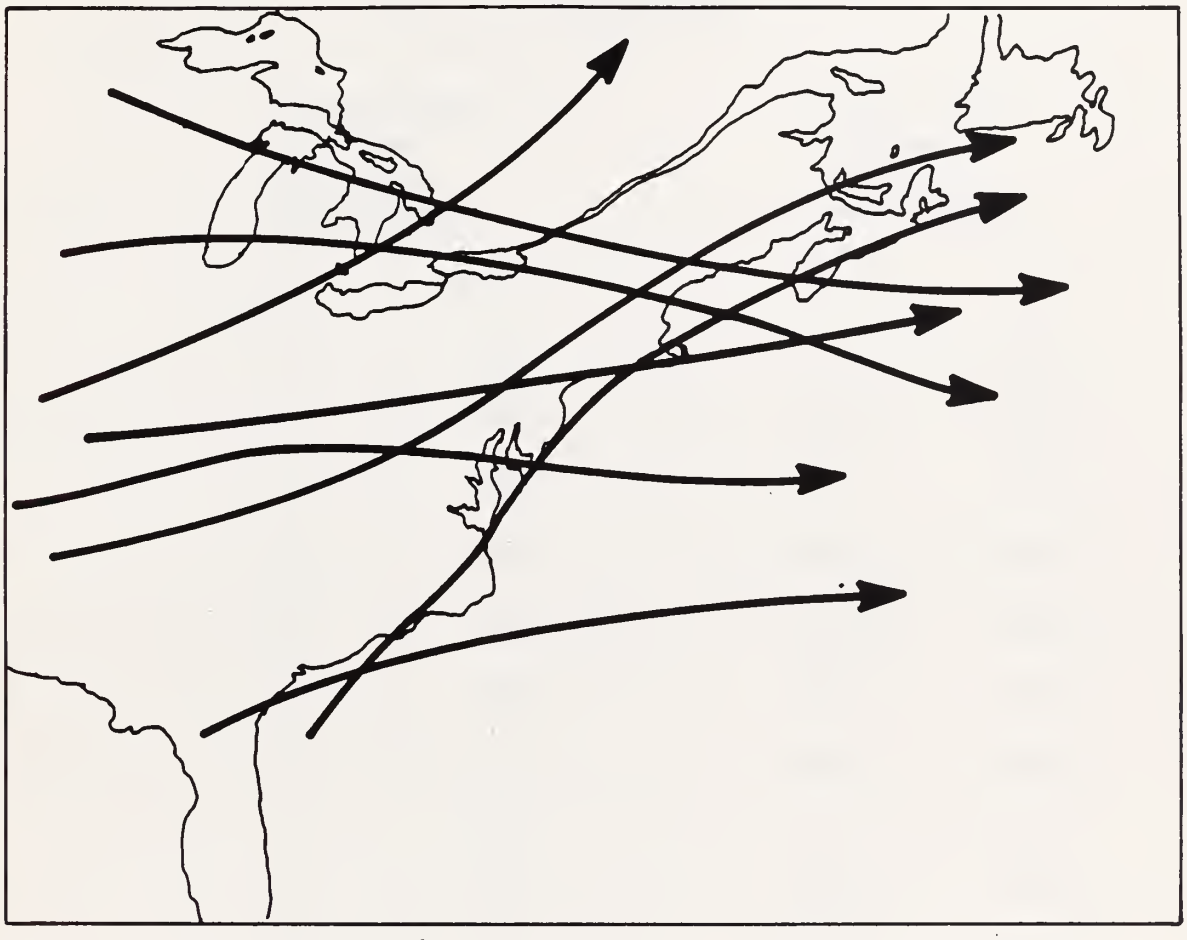
Precipitation

The annual average precipitation in Boston for the period of 1943 through 1982 was 41.40 inches with amounts ranging from as low as 23.71 inches in 1965 to as high as 62.32 inches in 1954. A maximum 24-hour rainfall value of 8.40 inches occurred in August 1955. Table 5.2.3-1 lists minimum and maximum monthly precipitation statistics for Boston, Massachusetts. Table 5.2.3-2 presents the average monthly and seasonal precipitation values.

The first measurable snowfall of winter usually occurs about the end of November, and the last snowfall in spring is generally near the middle of March. The average annual snowfall is 42 inches, with amounts ranging from as low as 10.3 inches in 1972-1973 to as high as 89.2 inches in 1947-48. Average monthly snowfall values are also presented in Table 5.2.3-2. A monthly maximum snowfall of 41.3 inches occurred in February 1969.




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 5.2.3-1<br>GENERAL MOVEMENT OF AIR MASSES WHICH FREQUENTLY AFFECT NEW ENGLAND |
|---|---|



| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 5.2.3-2<br>TYPICAL TRACKS OF LOW-PRESSURE SYSTEMS AFFECTING NEW ENGLAND |
|---|---|

TABLE 5.2.3-1

PRECIPITATION DATA FOR BOSTON
1952 to 1982

| | Minimum Monthly Precipitation in Inches and Year of Occurrence | | Maximum Monthly Precipitation in Inches and Year of Occurrence | |
|---|---|---|---|---|
| Jan | 0.74 | 1980 | 10.55 | 1979 |
| Feb | 0.88 | 1980 | 7.08 | 1969 |
| Mar | 0.62 | 1981 | 11.00 | 1953 |
| Apr | 1.24 | 1966 | 7.82 | 1958 |
| May | 0.25 | 1944 | 13.38 | 1954 |
| June | 0.48 | 1953 | 13.20 | 1982 |
| July | 0.52 | 1952 | 8.12 | 1959 |
| Aug | 0.83 | 1972 | 17.09 | 1955 |
| Sept | 0.35 | 1957 | 8.31 | 1954 |
| Oct | 0.34 | 1946 | 8.68 | 1962 |
| Nov | 0.64 | 1976 | 8.18 | 1969 |
| Dec | 0.97 | 1980 | 9.74 | 1969 |

Minimum yearly precipitation: 23.71 inches (1965)
Maximum yearly precipitation: 62.32 inches (1954)
Average yearly precipitation: 41.40 inches

SOURCE:

Department of Commerce, 1982. National Oceanic and Atmospheric Administration: Local Climatological Data, Annual Summary with Comparative Data. 1982. for General Logan International Airport, Boston, Massachusetts.

TABLE 5.2.3-2

MONTHLY AND SEASONAL CLIMATIC SUMMARY OF BOSTON, MASSACHUSETTS

| | Average Daily Maximum Temperature 1941-1970 (of) | Average Daily Minimum Temperature 1941-1970 (of) | Average Precipitation 1943-1982 (inches) | Average Snowfall 1943-1982 (inches) | Average Wind Speed 1958-1982 (mph) |
|---|---|---|---|---|---|
| December | 39.3 | 26.6 | 3.65 | 8.0 | 13.6 |
| January | 35.9 | 22.5 | 3.67 | 12.6 | 14.2 |
| February | 37.5 | 23.3 | 3.38 | 11.6 | 14.0 |
| Winter Average | 37.6 | 24.1 | 10.70 | 32.2 | 13.9 |
| March | 44.6 | 31.5 | 3.79 | 7.7 | 13.8 |
| April | 56.3 | 40.8 | 3.55 | 0.9 | 13.5 |
| May | 67.1 | 50.1 | 3.23 | Trace | 12.1 |
| Spring Average | 56.0 | 40.8 | 10.57 | 8.6 | 13.1 |
| June | 76.6 | 59.3 | 3.17 | 0.0 | 11.4 |
| July | 81.4 | 65.1 | 3.13 | 0.0 | 10.8 |
| August | 79.3 | 63.3 | 3.57 | 0.0 | 10.7 |
| Summer Average | 79.1 | 62.6 | 9.87 | 0.0 | 11.0 |
| September | 72.2 | 56.7 | 3.18 | 0.0 | 11.2 |
| October | 63.2 | 47.5 | 3.25 | Trace | 12.0 |
| November | 51.7 | 38.7 | 3.83 | 1.2 | 12.9 |
| Fall Average | 62.4 | 47.6 | 10.26 | 1.2 | 12.0 |

SOURCE:

Department of Commerce, 1982. National Oceanic and Atmospheric Administration: Local Climatological Data Annual Summary with Comparative Data, 1982, for General Logan International Airport, Boston, Massachusetts.

Temperature

The mean annual temperature is about 50° F, but seasonal variations bring tropical warmth of 90° F or greater in the summer and polar cold of 0° F or less in winter. The coldest months are January and February, averaging about 29° F. The record minimum temperature of -12° F was recorded in January 1957. July and August average near 70° F with a record maximum temperature of 102° F recorded in July 1977. Freezing temperatures occur on an average of 99 days per year from mid-November through March, and very warm days of 90° F or higher average 12 occurrences annually. The average daily maximum and minimum temperature values by month and season are also presented in Table 5.2.3-2.

Fog

Heavy fog is not uncommon in Boston, but usually lasts less than a day. Contrasting temperature differences over the North Atlantic Ocean often create large fog banks which can move inland across southeastern New England any time of the year. The fog can lower visibility to 1/4 mile or less. Such dense fog occurs on an average of two times per month.

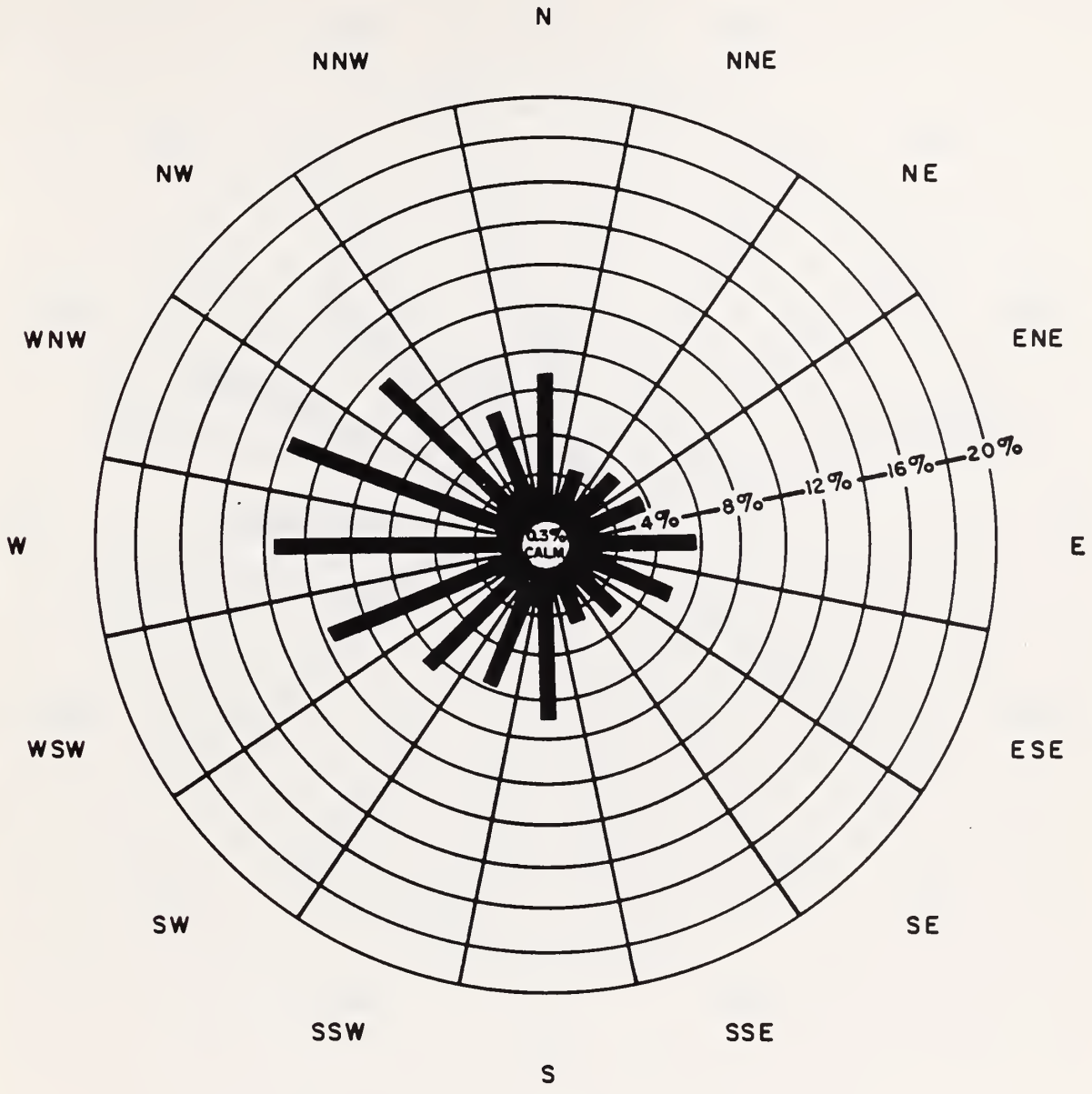
Relative Humidity

The annual average relative humidity in Boston is 67 percent. The average of the highest daily relative humidity values is 72 percent. These highest daily values are experienced at night and during early morning hours. The drier afternoon and evening hours average 58 percent and 65 percent at 1:00 p.m. and 7:00 p.m., respectively.

Wind Speed and Wind Direction

Figure 5.2.3-3 depicts the annual frequency distribution of wind direction at Boston. The most frequent (11.8 percent) wind direction is west-northwest and the least frequent (2.3 percent) wind direction is south-southeast. Figures 5.2.3-4 through 5.2.3-7 present the seasonal frequencies of wind direction at Boston. During the winter season, (December - February), the wind is predominately from the west-northwest, with the winds blowing from the west through (clockwise) northwest approximately 45 percent of the time. During the spring (March - May), the most frequent (11.5 percent) wind direction remains west-northwest. However, the frequency of wind directions from the northeast through (clockwise) southeast is significantly increased from winter because of the sea breeze phenomenon. The most prevalent (11.4 percent) wind direction during the summer is west-southwest, with the winds blowing from the south through (clockwise) west almost half (48 percent) of the time. The effect of the sea breeze on the summer frequency distribution is evident with a pronounced secondary maximum (19.5 percent) occurring between east and southeast. During the fall, the prevalent (10.6 percent) wind direction is west.

The annual average hourly wind speed is 12.5 mph. Calm conditions are infrequent (0.3 percent). Average monthly wind speeds are summarized in Table 5.2.3-2. Wind speeds are highest during the winter, reflecting the increase in the frequency of intense storms affecting

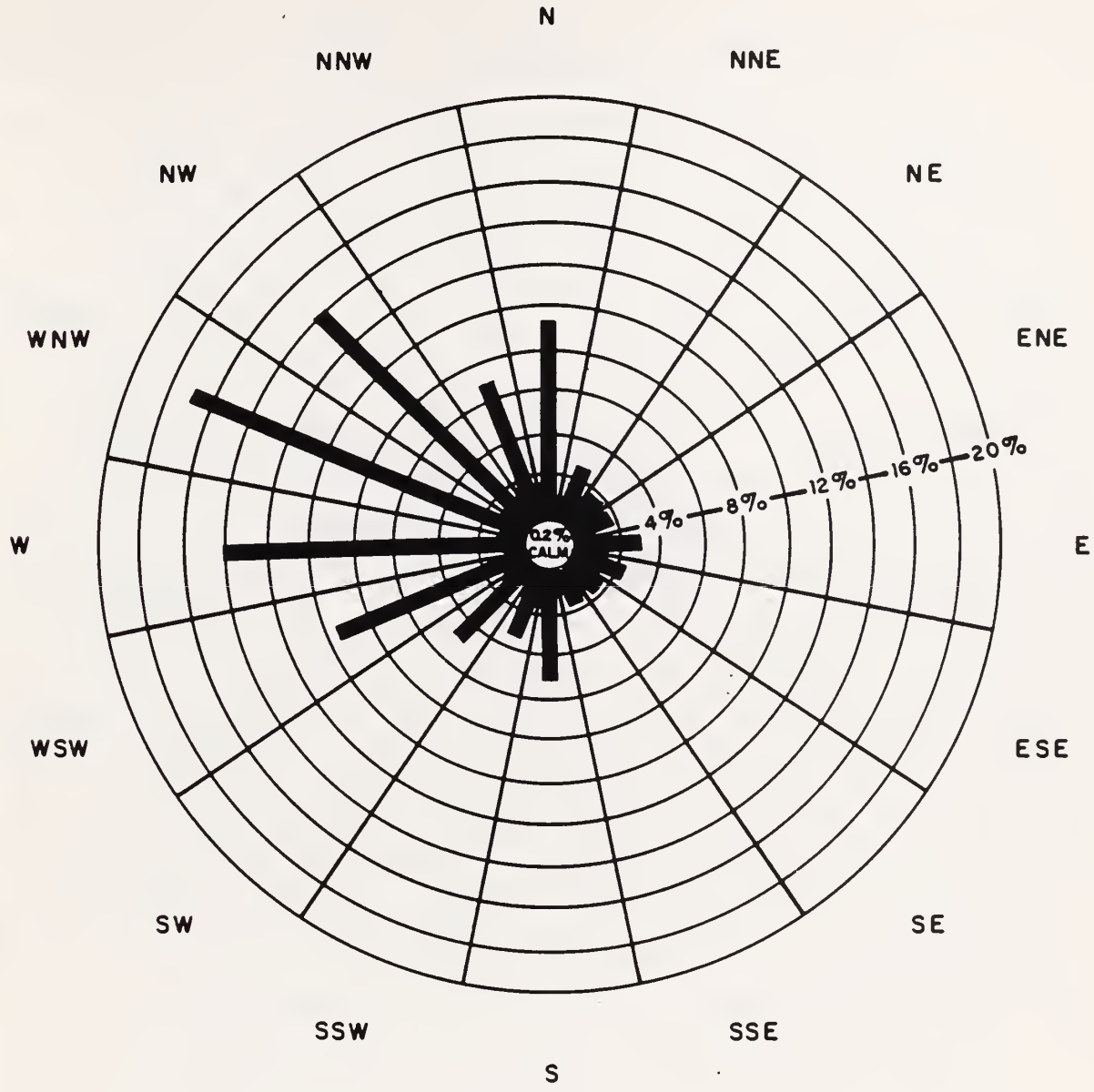



NOTE
DIRECTION REPRESENTS SECTOR
FROM WHICH THE WIND BLOWS

SOURCE: National Climatic Center
Asheville, NC.

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.3-3**
**ANNUAL FREQUENCY DISTRIBUTION (PERCENTAGE OCCURANCE) OF WIND DIRECTION FOR BOSTON, MASSACHUSETTS**

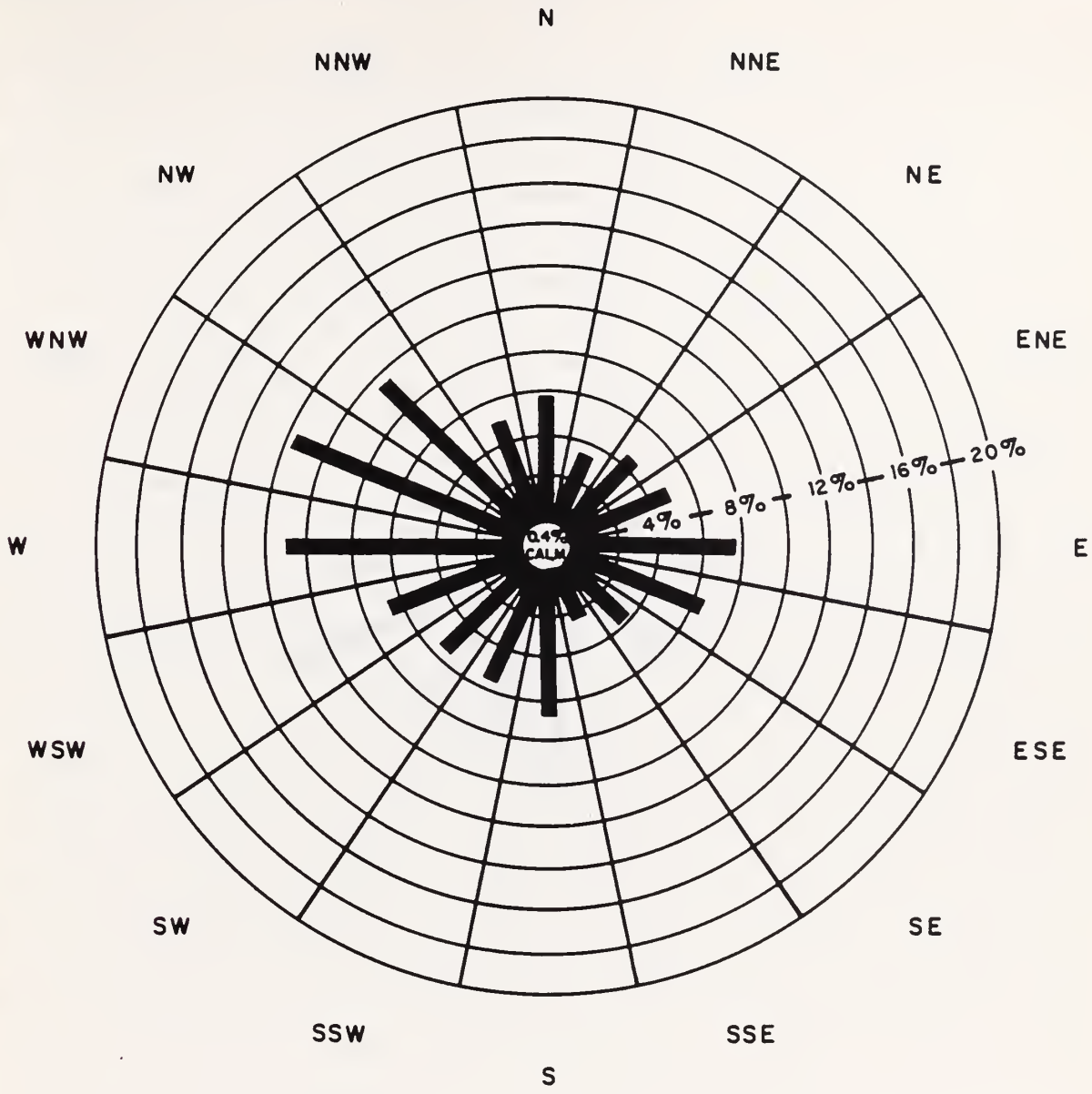



NOTE
DIRECTION REPRESENTS SECTOR
FROM WHICH THE WIND BLOWS

SOURCE: National Climatic Center
Asheville, NC.

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.3-4**
**WINTER FREQUENCY DISTRIBUTION (PERCENTAGE OCCURANCE) OF WIND DIRECTION FOR BOSTON, MASSACHUSETTS**

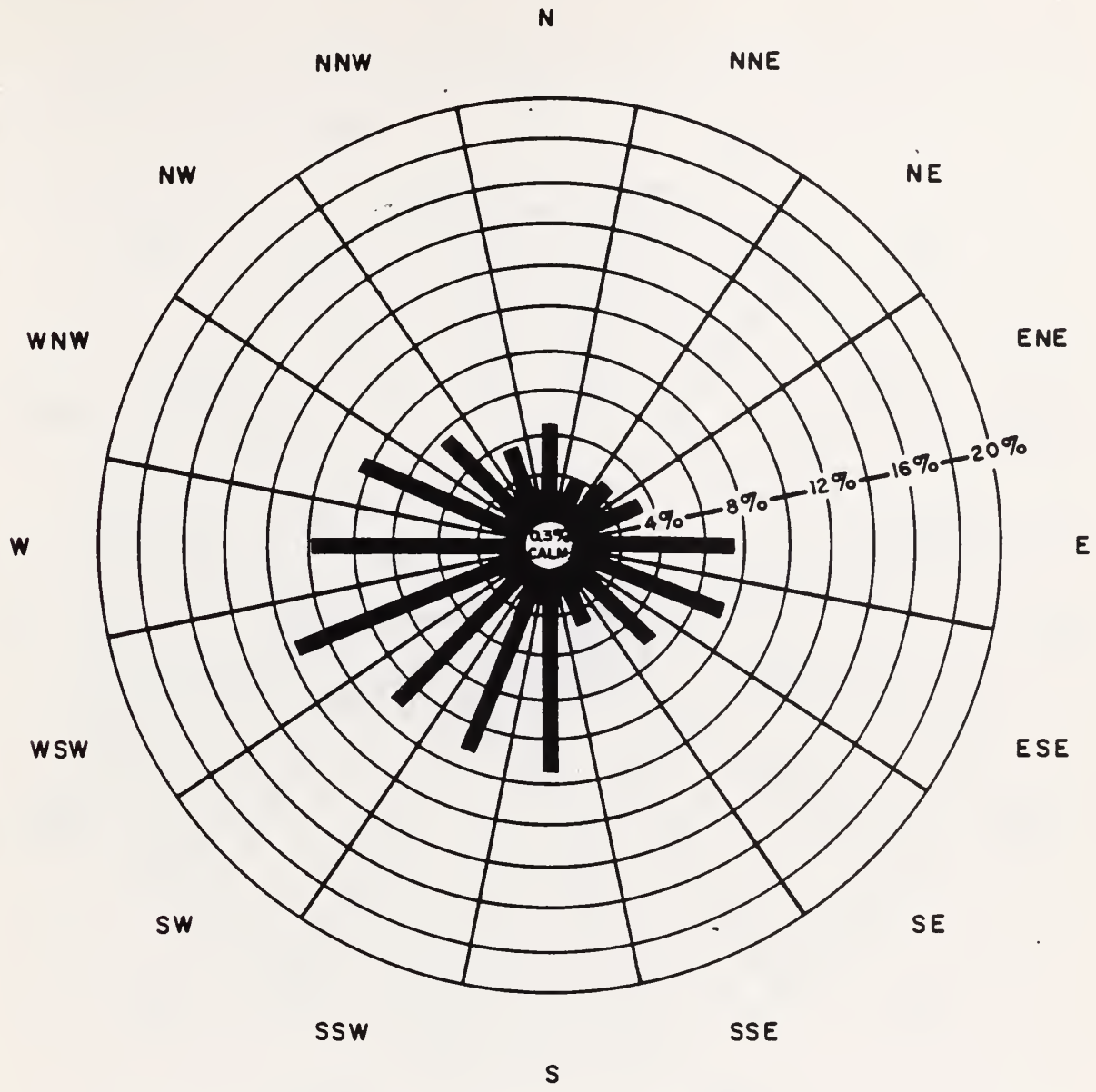



NOTE
DIRECTION REPRESENTS SECTOR
FROM WHICH THE WIND BLOWS

SOURCE: National Climatic Center
Asheville, NC.

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.3-5**
**SPRING FREQUENCY DISTRIBUTION (PERCENTAGE OCCURANCE) OF WIND DIRECTION FOR BOSTON, MASSACHUSETTS**

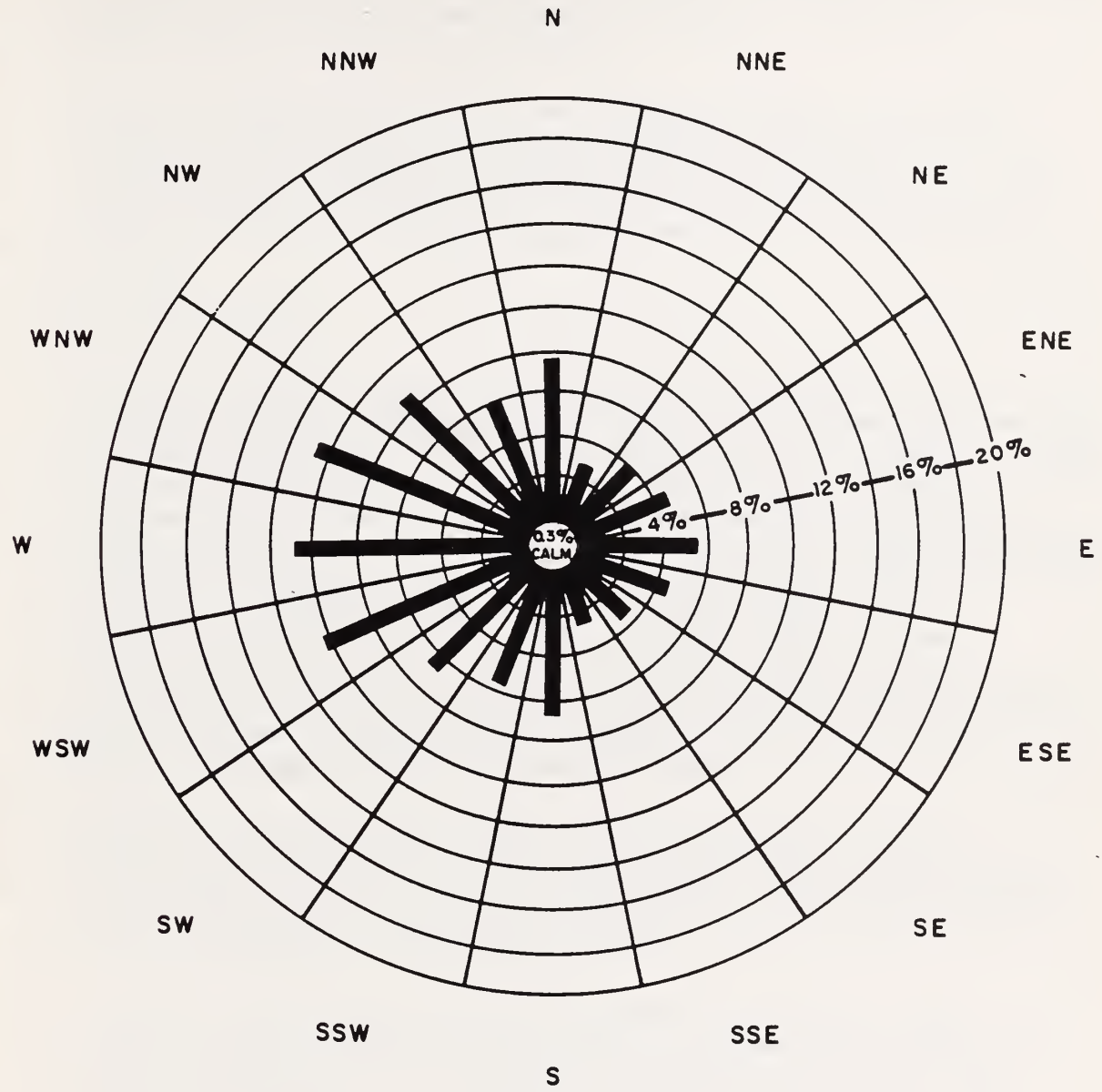



NOTE
DIRECTION REPRESENTS SECTOR
FROM WHICH THE WIND BLOWS

SOURCE: National Climatic Center
Asheville, NC.

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.3-6**
**SUMMER FREQUENCY DISTRIBUTION (PERCENTAGE OCCURANCE) OF WIND DIRECTION FOR BOSTON, MASSACHUSETTS**




NOTE
DIRECTION REPRESENTS SECTOR
FROM WHICH THE WIND BLOWS

SOURCE: National Climatic Center
Asheville, NC.

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.3-7**
**FALL FREQUENCY DISTRIBUTION (PERCENTAGE OCCURANCE) OF WIND DIRECTION FOR BOSTON, MASSACHUSETTS**

New England. Wind speeds are lowest during the summer,which is the period that lacks organized large-scale storm activity, although short duration high wind gusts can occur during this season as a result of localized thunderstorm activity.

Table 5.2.3-3 presents seasonal and annual wind speeds per wind direction. A west-northwest wind direction is associated with the highest annual average wind speed of 13.9 mph and a south-southeast wind is associated with the lowest annual average wind speed of 8.5 mph. These directions correspond with the highest and lowest average wind speed directions of the winter season. During the summer, a south-southwest wind is associated with the highest wind speed of 11.7 mph.

## 5.2.4 AIR QUALITY

Federal and state air pollution control to date has focused on the six major pollutants for which National Ambient Air Quality Standards (NAAQS) have been established in accordance with the Clean Air Act (CAA) and its 1977 amendments. Known as the "criteria pollutants", the NAAQS include total suspended particulates (TSP), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO), ozone ($0_3$), and lead (Pb). Non-methane hydrocarbon standards were revoked on January 5, 1983 [48FR628]. Primary standards are intended to safeguard human health by setting limits on the amount of pollution allowed in the surrounding air so as to protect the population with a significant margin of safety. The margin of safety is to ensure protection of more sensitive groups such as children, the elderly, and the ill. Secondary standards are meant to protect public welfare by preventing adverse effects on animals, agricultural crops, man-made materials and property, personal comfort and well being, and other factors. The degree of stringency of the primary standards, as opposed to the secondary standards, is dependent upon results of extensive health analyses.

Under the CAA, individual states must adopt criteria pollutant standards in their State Implementation Plans (SIPs) that are at least as stringent as the NAAQS. Table 5.2.4-1 lists the Massachusetts and National Ambient Air Quality Standards. The primary method of ensuring that the standards are attained and maintained is through the control of the emissions of these pollutants, specifically from mobile and stationary sources.

In addition to criteria pollutants, the CAA requires control of other airborne compounds including radionuclides. Known as "noncriteria pollutants", regulation of these substances has been more difficult to achieve. This is due largely to the uncertainty of the origin of their emissions, the atmospheric chemistry involved during transport, and the significance, if any, of their health effects. Emissions standards for some of the noncriteria pollutants have been established (40CFR61) and are known as the National Emission Standards for Hazardous Air Pollutants (NESHAP). These hazardous air pollutants include asbestos, beryllium, mercury, and vinyl chlorides. The intent of NESHAP is to provide nationally uniform control requirements through specific emission limitations, work practices, and/or equipment standards. The NESHAP control requirements are set at a level that provides an ample margin of safety to protect the public health.

TABLE 5.2.3-3

SEASONAL AND ANNUAL AVERAGE WIND SPEED (MPH)
PER WIND DIRECTION AT LOGAN AIRPORT (1970-1981)

| Wind Direction | Winter | Spring | Summer | Fall | Annual |
|---|---|---|---|---|---|
| N | 11.5 | 10.8 | 8.6 | 10.0 | 10.4 |
| NNE | 10.3 | 11.1 | 8.5 | 9.7 | 10.0 |
| NE | 12.5 | 12.9 | 10.5 | 12.0 | 12.0 |
| ENE | 14.5 | 12.0 | 9.1 | 11.5 | 11.5 |
| E | 14.0 | 11.6 | 9.7 | 11.0 | 11.1 |
| ESE | 11.5 | 11.7 | 10.2 | 10.3 | 10.8 |
| SE | 9.4 | 9.0 | 8.2 | 9.0 | 8.8 |
| SSE | 9.1 | 8.9 | 7.3 | 8.7 | 8.5 |
| S | 10.9 | 10.8 | 9.7 | 9.9 | 10.2 |
| SSW | 13.2 | 13.3 | 11.7 | 12.0 | 12.4 |
| SW | 13.4 | 12.7 | 11.5 | 12.0 | 12.2 |
| WSW | 13.5 | 12.1 | 11.1 | 12.1 | 12.1 |
| W | 15.4 | 14.7 | 11.1 | 13.5 | 13.8 |
| WNW | 15.5 | 14.6 | 11.2 | 13.0 | 13.9 |
| NW | 14.0 | 13.3 | 10.8 | 12.2 | 12.9 |
| NNW | 12.2 | 12.4 | 10.4 | 11.0 | 11.6 |

## TABLE 5.2.4-1
## MASSACHUSETTS AND NATIONAL AMBIENT AIR QUALITY STANDARDS

| Criteria Pollutant | Averaging Interval [1] | Primary Standard ($ug/m^3$) | Primary Standard (ppm) | Secondary Standard ($ug/m^3$) | Secondary Standard (ppm) |
|---|---|---|---|---|---|
| Sulfur Dioxide | Annual | 80 | 0.03 | - | - |
| | 24-hr | 365 | 0.14 | - | - |
| | 3-hr | - | - | 1,300 | 0.5 |
| Total Suspended Particulate | Annual | 75 [2] | - | 60 [2,3] | - |
| | 24-hr | 260 | - | 150 | - |
| Nitrogen Dioxide | Annual | 100 | 0.05 | 100 | 0.05 |
| | 1-hr | 320 | 0.19 | - | - |
| Carbon Monoxide | 8-hr | 10 [5] | 9 | 10 [5] | 9 |
| | 1-hr | 40 [5] | 35 | 40 [5] | 35 |
| Ozone | 1-hr [6] | 240 | 0.12 | 240 | 0.12 |
| Lead | 3-month [7] | 1.5 | - | 1.5 | - |

NOTES:

1. 1-hr, 3-hr, 8-hr, and 24-hr standards not to be exceeded more than once per year. Arithmetic mean for 3-month and annual standards except particulate matter.

2. Annual geometric mean.

3. For use as a guide in assessing implementation plans to achieve the 24-hr standard.

4. Massachusetts Department of Environmental Quality Engineering guideline, applicable only to major sources or major modifications of oxides of nitrogen.

5. Carbon monoxide standards are shown in units of $mg/m^3$.

6. Standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above standard is equal to or less than one.

7. Maximum arithmetic mean average over a calendar quarter.

Determination of progress being achieved in attaining and/or maintaining the NAAQS is accomplished through ambient air quality monitoring. Under the CAA, the state must provide for ambient air quality monitoring at selected locations within specified areas under its jurisdiction, known as Air Quality Control Regions (AQCRs). The state must make available on an annual basis the present ambient conditions on a pollutant-specific basis. In addition to the state-operated network, ambient monitoring data are also collected by local agencies, corporations, universities, etc.

Deer Island is located in the state-designated Metropolitan Boston Air Pollution Control District and the federally designated Metropolitan Boston Air Quality Control Region 119 (AQCR). Ambient air quality monitoring data representative of the region surrounding Deer Island were obtained from the Massachusetts Department of Environmental Quality Engineering. The ambient air quality data presented in this section are essentially inclusive of the period 1981 through 1985 for the criteria pollutants. Table 5.2.4-2 lists monitoring sites, station identification (Storage and Retrieval of Aerometric Data [SAROAD] numbers, operators, pollutants monitored, and Universal Transverse Mercator (UTM) coordinates.

Ambient air quality data summaries are provided below for each criteria pollutant. Existing air quality concentrations are compared to the appropriate ambient air quality standards shown in Table 5.2.4-1. In addition, a summary of the area's attainment status on a pollutant-specific basis is provided in Table 5.2.4-3.

Total Suspended Particulates (TSP)

A summary of TSP ambient air quality data is presented in Table 5.2.4-4. No violations of primary or secondary standards were recorded during the time frame.

No ambient data depicting the TSP concentrations in the immediate vicinity of Deer Island are presently available. TSP concentrations recorded in 1981 through 1985 at the nearby Long Island monitoring station, located less than 2 miles from Deer Island, were in compliance with all standards.

In a study performed in 1977 to determine the elemental composition of TSP in metropolitan Boston, it was reported that between 51 and 59 percent of all particulates originate from the soil and are entrained into the atmosphere by vehicle activity, construction and demolition, and the action of the wind (Wiltsee 1977). In addition, it was determined that the burning of residual oil fuel for power generation from all sources contributes only 2 to 5 percent of the TSP concentrations in metropolitan Boston.

Sulfur Dioxide ($SO_2$)

Ambient monitoring data for $SO_2$ are summarized in Table 5.2.4-5. There were no violations of either the 3-hour, 24-hour, or annual ambient standards of 1300 micro-grams per cubic meter ($ug/m^3$), 365 $ug/m^3$ and 80 $ug/m^3$, respectively, at any site in the vicinity of Deer Island

## TABLE 5.2.4-2

## AMBIENT AIR QUALITY MONITORING STATIONS

| Monitoring Site (SAROAD No.) | Operated By | Pollutant(s) Monitored | UTM Coordinates X | UTM Coordinates Y |
|---|---|---|---|---|
| 1. Deer Island<br>Boston<br>(0240-026) | DEQE | $SO_2$, $NO_2$ | 337.9 | 4690.2 |
| 2. Atlantic Ave<br>Boston<br>(0240-018) | BECO | TSP, $SO_2$, SO4 | 30.8 | 4690.8 |
| 3. Long Island<br>Boston<br>(0240-019) | BECO | TSP, $SO_2$, SO4 | 337.6 | 4686.6 |
| 4. Bremen St.<br>East Boston<br>(0240-021) | DEQE<br>BECO | TSP, $SO_2$, $NO_2$, C0,$0_3$<br>TSP, $SO_2$, $SO_4$ | 332.7 | 4693.4 |
| 5. Chestnut and 6th<br>Chelsea<br>(0380-002) | DEQE | TSP, Pb | 332.5 | 4695.1 |
| 6. Power Horn Hill<br>(0380-003) | DEQE<br>Chelsea | $SO_2$, $NO_2$, $O_3$ | 339.9 | 4675.8 |

TABLE 5.2.4-3

ATTAINMENT STATUS DESIGNATIONS OF AIR QUALITY CONTROL REGION (AQCR) 119

| Criteria Pollutant | Area | Status |
|---|---|---|
| TSP | Boston | Cannot be classified or better than national standards |
| $SO_2$ | Entire State | Better than national standards |
| $NO_2$ | Entire State | Cannot be classified or better than national standards |
| CO | Boston | Does not meet primary standards |
| $O_3$ | Entire State | Does not meet primary standards |
| Pb | Entire State | Currently no designations |

TABLE 5.2.4-4

AMBIENT AIR QUALITY DATA SUMMARY
FOR TOTAL SUSPENDED PARTICULATES

| Monitoring Site | Year | 24hr Average Concentration Highest ($ug/m^3$) | 2nd Highest ($ug/m^3$) | Annual Geometric Mean ($ug/m^3$) |
|---|---|---|---|---|
| Atlantic Ave | 1981 | --- | --- | --- |
| Boston | 1982 | --- | --- | --- |
| | 1983 | --- | --- | --- |
| | 1984 | 177 | 139 | 56 |
| | 1985 | --- | --- | --- |
| Long Island | 1981 | --- | --- | --- |
| Boston | 1982 | --- | --- | --- |
| | 1983 | --- | --- | --- |
| | 1984 | 50 | 49 | 25 |
| | 1985 | --- | --- | --- |
| Bremen St | 1981 | --- | --- | --- |
| East Boston | 1982 | --- | --- | --- |
| | 1983 | 100 | 95 | 52 |
| | 1984 | 107 | 97 | 40 |
| | 1985 | --- | --- | --- |
| Chestnut and 6th | 1981 | 149 | 128 | 57 |
| Chelsea | 1982 | 118 | 104 | 50 |
| | 1983 | 127 | 106 | 50 |
| | 1984 | 125 | 118 | 54 |
| | 1985 | --- | --- | --- |

TABLE 5.2.4-5

AMBIENT AIR QUALITY DATA SUMMARY
FOR SULFUR DIOXIDE

| Monitoring Site | Year | 3-hr Running Average Highest ($ug/m^3$) | 3-hr Running Average 2nd Highest(1) ($ug/m^3$) | 24-Hr Daily Average Highest ($ug/m^3$) | 24-Hr Daily Average 2nd Highest(1) ($ug/m^3$) | Annual Arithmetic Mean(2) ($ug/m^3$) |
|---|---|---|---|---|---|---|
| Deer Island | 1981 | --- | --- | --- | --- | --- |
| Boston | 1982 | 179 | 178 | 96 | 60 | --- |
| | 1983 | --- | --- | --- | --- | --- |
| | 1984 | --- | --- | --- | --- | --- |
| | 1985 | --- | --- | --- | --- | --- |
| Atlantic Ave. | 1981 | 359 | 280 | 191 | 147 | 41 |
| Boston | 1982 | --- | --- | --- | --- | --- |
| | 1983 | --- | --- | --- | --- | --- |
| | 1984 | 288 | 288 | 168 | 134 | 35 |
| | 1985 | --- | --- | --- | --- | --- |
| Long Island | 1981 | 233 | 196 | 113 | 104 | 23 |
| Boston | 1982 | --- | --- | --- | --- | --- |
| | 1983 | --- | --- | --- | --- | --- |
| | 1984 | 236 | 210 | 254 | 238 | 19 |
| | 1985 | --- | --- | ---- | --- | --- |
| 340 Bremen St. | 1981 | 215 | 204 | 126 | 102 | 37 |
| East Boston | 1982 | 364 | 281 | 128 | 116 | 37 |
| | 1983 | --- | --- | --- | --- | --- |
| | 1984 | 279 | 261 | 171 | 141 | 34 |
| | 1985 | --- | --- | --- | --- | --- |
| Power Horn Hill | 1981 | --- | ---- | --- | --- | --- |
| Chelsea | 1982 | --- | ---- | --- | --- | --- |
| | 1983 | --- | --- | --- | --- | --- |
| | 1984 | 367 | 263 | 109 | 102 | 24 |
| | 1985 | --- | --- | --- | --- | --- |

NOTES:

1. Standard compliance is determined by comparing the second highest recorded value to the 3-hour standard of 1300 $ug/m^3$ and the 24-hour standard of 365 $ug/m^3$.

2. Annual standard is 80 $ug/m^3$.

during the period from 1981 through 1985. It is clear that $SO_2$ concentrations in the vicinity of Deer Island are well within all standards.

An evaluation of the trends of $SO_2$ concentrations in metropolitan Boston shows that regional levels fell consistently from 1971 to 1974, with the steepest decline occurring in the urban core. Annual average concentrations for the entire metropolitan Boston area fell from 41 $ug/m^3$ in 1971 to 18 $ug/m^3$ in 1974. At the same time, $SO_2$ concentrations in downtown Boston declined from 63 $ug/m^3$ in 1971 to 19 $ug/m^3$ in 1974.

The dramatic decrease in annual average $SO_2$ concentrations between 1971 and 1974 was a result of sulfur-in-fuel regulations. Because of the lower $SO_2$ ambient levels in 1974 and the increased cost of low-sulfur fuel oil, new legislation (Massachusetts General Laws of 1974, Chapter 494) allowed utilities and industries meeting specific stringent conditions (e.g., protection of standards and public health) to burn higher sulfur fuel oil. As a result, ambient $SO_2$ levels increased slightly between 1975 and 1978 but remained well within all ambient standards.

Since 1978, the overall annual average $SO_2$ concentrations in metropolitan Boston have consistently remained between 33 and 36 $ug/m^3$, which is only 40 to 46 percent of the annual standard. However, concentrations did vary significantly from station-to-station. Kenmore Square monitoring station, for example, has consistently recorded annual average concentrations between 50 and 55 $ug/m^3$, while concentrations recorded at Long Island ranged between 22 and 26 $ug/m^3$.

Nitrogen Dioxide ($NO_2$)

A summary of annual $NO_2$ ambient data from 1981 to 1985 is provided in Table 5.2.4-6. No $NO_2$ monitoring station in the vicinity of Deer Island recorded a violation of the annual standard of 100 $ug/m^3$. The entire region is currently designated as "better than national standards" for $NO_2$.

In addition to the State and Federal standard for annual average concentrations, Massachusetts DEQE has followed its own policy for short-term $NO_2$ concentrations applicable to new or modified major sources of oxides of nitrogen (NOx). Specifically, new or modified major sources of NOx that increase emissions to the atmosphere by more than 250 tons per year must demonstrate that the operation of the source will not, with consideration of ambient background, cause or significantly contribute to $NO_2$ concentrations in excess of 320 $ug/m^3$ for any 1-hour period on more than 1 day per year.

Highest and second highest 1-hour average $NO_2$ concentrations are provided in Table 5.2.4-6. Concentrations recorded at Deer Island and Power Horn Hill in Chelsea show some violations of the Massachusetts 1-hour guideline of 320 $ug/m^3$.

Ambient levels of $NO_2$ are primarily a result of NOx emissions from motor vehicles and stationary combustion sources. It is estimated that motor vehicle emissions constitute 45

TABLE 5.2.4-6

AMBIENT AIR QUALITY DATA SUMMARY
FOR NITROGEN DIOXIDE

| Monitoring Site | Year | 1hr Average Concentration Highest ($ug/m^3$) | 1hr Average Concentration 2nd Highest ($ug/m^3$) | Annual Arithmetic Mean[1] ($ug/m^3$) |
|---|---|---|---|---|
| Deer Island | 1981 | --- | --- | --- |
| Boston | 1982 | 433 | 395 | 60 |
| | 1983 | 304 | 234 | 30 |
| | 1984 | --- | --- | --- |
| | 1985 | --- | --- | --- |
| Bremen St | 1981 | 214 | 207 | 55 |
| East Boston | 1982 | 303 | 258 | 43 |
| | 1983 | 332 | 286 | 50 |
| | 1984 | 333 | 263 | 61 |
| | 1985 | --- | --- | --- |
| Power Horn Hill | 1981 | | | |
| Chelsea | 1982 | | | |
| | 1983 | | | |
| | 1984 | 667 | 517 | 42 |
| | 1985 | | | |

NOTE:

1. Annual standard is 100 $ug/m^3$.

percent of all NOx emissions, while stationary combustion sources contribute 50 percent. Electric utilities are responsible for approximately 56 percent of the NOx emissions from stationary combustion sources (EPA 1979). It follows, then, that approximately 30 percent of all NOx emissions are attributable to electric utilities. Because of their elevated stacks, stationary sources are generally far less significant contributors to ground-level ambient concentrations of $NO_2$ than motor vehicles.

Determination of trends in $NO_2$ concentrations from 1971 to 1977 is more difficult to accomplish and conclusions are probably less reliable than for the other criteria pollutants due to the sparsity of the data base and the lack of continuous measurement equipment. However, DEQE is of the opinion that, based on the available non-continuous data, the ambient concentrations at almost all its monitoring stations were in compliance with the annual standard of 100 ug/$m^3$ for the period from 1971 to 1977 (DEQE 1978). In 1977, when continuous monitoring became more readily available, only those sites located close to heavily traveled roadways (i.e., the NOx source of most concern) were retained. From 1977 to 1981, the more reliable continuous monitoring data have not revealed any discernible trend in annual $NO_2$ concentrations.

Carbon Monoxide (CO)

Table 5.2.4-7 summarizes CO ambient air quality data from 1981 through 1985. No violation of the primary and secondary 1-hour standard of 40 mg/$m^3$ was recorded at any station during the 4-year period analyzed. However, violations of the 8-hour standard of 10 mg/$m^3$ have occurred at the East Boston monitoring sites.

Trend data for CO are available for the period from 1973 to 1981. These data are generally reported in terms of number of violations of the 8-hour standard, and annual average concentrations (although no annual standards exist for CO). Results show a significant and continuous decrease in both the number of 8-hour violations and annual average concentrations in metropolitan Boston throughout the period. This is directly attributable to the replacement of older, less efficient automobiles with newer models equipped with emission control systems. The continuous long-term decrease in CO concentrations is not unexpected since CO emissions are largely caused by automobile exhaust.

Ozone

Two monitoring stations in the general vicinity of Deer Island have collected ozone data during the 5-year period analyzed (1981-1985). One violation of the ambient standard for ozone has occurred during the period. The highest and second highest 1-hour concentrations of ozone are listed in Table 5.2.4-8. The EPA attainment status designation lists the entire area as "nonattainment".

Ozone is a widespread problem, not limited to any one specific area. Ozone moves easily over great distances, and local violations are often the result of such mobility.

Ozone concentrations are in large part due to the emissions of volatile organic compounds

TABLE 5.2.4-7

AMBIENT AIR QUALITY DATA SUMMARY
FOR CARBON MONOXIDE

| | | 1hr Average | | 8hr Average | |
|---|---|---|---|---|---|
| Monitoring Site | Year | Highest ($mg/m^3$) | 2nd Highest(1) ($mg/m^3$) | Highest ($mg/m^3$) | 2nd Highest(1) ($mg/m^3$) |
| 340 Bremen St | 1981 | 12 | 12 | 10 | 8 |
| East Boston | 1982 | 17 | 17 | 11 | 10 |
| | 1983 | -- | -- | -- | -- |
| | 1984 | 16 | 14 | 8 | 7 |
| | 1985 | -- | -- | -- | -- |

NOTE:

1. Standard compliance is determined by comparing the second highest recorded value to the 1-hour standard of 40 $mg/m^3$ and the 8-hour standard of 10 $mg/m^3$.

TABLE 5.2.4-8

AMBIENT AIR QUALITY
DATA SUMMARY FOR OZONE

| Monitoring Site | Year | 1hr Average Highest (ppm) | 1hr Average 2nd Highest(1) (ppm) |
|---|---|---|---|
| 340 Bremen St | 1981 | 0.115 | 0.095 |
| East Boston | 1982 | 0.145 | 0.117 |
| | 1983 | 0.112 | 0.110 |
| | 1984 | 0.107 | 0.073 |
| | 1985 | --- | --- |
| Power Horn Hill | 1981 | --- | --- |
| Chelsea | 1982 | --- | --- |
| | 1983 | --- | --- |
| | 1984 | 0.125 | 0.125 |
| | 1985 | --- | --- |

NOTE:

1. Standard compliance is determined by comparing the second highest recorded value to the 1-hour standard of 0.12 ppm.

(VOC), NOx, and, to a lesser extent, CO generated by transportation-related sources, in particular, the automobile. However, VOC emissions from industrial sources and NOx emissions from utility sources are also believed to contribute to ozone formation. Emissions of these pollutants in the presence of sunlight are believed to trigger photochemical oxidation leading to the production of ozone (EPA 1979). Although the detailed formation processes are not well known, traditional opinion in the scientific community is that ozone is formed in the stratosphere (i.e., above 7.5 miles) and transported to the ground in the vicinity of frontal zones or breaks in the tropopause which separates the stratosphere from the troposphere (Danielson 1977). Hence, local emissions of the precursor pollutants are not thought to significantly contribute to local ozone concentrations, but are instead transported downwind while undergoing the photochemical oxidation process.

The attempt at reducing ozone concentrations in metropolitan Boston and elsewhere is based on a cooperative effort by federal, state, and local agencies in limiting the precursor pollutants with the emphasis placed on the control of automotive exhaust. However, progress achieved to date in reducing ozone concentrations through control strategies is difficult to discern. Analysis of trend data (1973 through 1981), generally reported in terms of number of standard violations per year, shows no clear trend in ambient concentrations of ozone. Annual variations in the number of recorded 1-hour violations appear to be more dependent upon meteorology than any significant change in precursor emissions.

Lead

Unlike the other criteria pollutants for which standards were established during the early 1970's, the ambient standard for lead was promulgated in October 1978. The ambient standard is 1.5 $ug/m^3$, maximum arithmetic mean concentration averaged over a calendar quarter. In addition to the relatively recent promulgation of the lead standard, ambient air quality monitoring, data reporting, and surveillance provisions for this pollutant have been slow to evolve because of technical uncertainties. Primarily as a result of this, the existing data base for lead is limited to one site in the general vicinity of Deer Island: Chestnut and 6th Street, Chelsea. Ambient monitoring data collected from 1981 to 1985 at this site are presented in Table 5.2.4-9. No violations of the standard have been recorded at this monitoring site. Lead ambient standard attainment designations have not yet been promulgated for Massachusetts.

Lead is emitted to the atmosphere by vehicles burning leaded fuel and by certain stationary sources which include lead smelters, gasoline lead additive manufacturers, and lead storage battery manufacturers.

TABLE 5.2.4-9

AMBIENT AIR QUALITY
DATA SUMMARY FOR LEAD[1]

| Monitoring Site | Year | Quarter | Quarterly Arithmetic Mean[2] ($ug/m^3$) |
|---|---|---|---|
| Chestnut and 6th Chelsea | 1981 | Second | --- |
| | | Fourth | --- |
| | 1982 | First | 0.54 |
| | | Second | 0.33 |
| | | Third | 0.46 |
| | | Fourth | 0.42 |
| | 1983 | First | 0.26 |
| | | Second | 0.23 |
| | | Third | 0.37 |
| | | Fourth | 0.40 |
| | 1984 | First | 0.27 |
| | | Second | 0.26 |
| | | Third | 0.27 |
| | | Fourth | 0.34 |
| | 1985 | --- | --- |

NOTES:

1. Federally compiled data, EPA/atmospheric surveillance.

2. Standard compliance is determined by comparing the recorded quarterly arithmetic mean to 1.5 $ug/m^3$.

## 5.2.5 LAND USE AND VISUAL CHARACTER

### Deer Island

#### Land Use

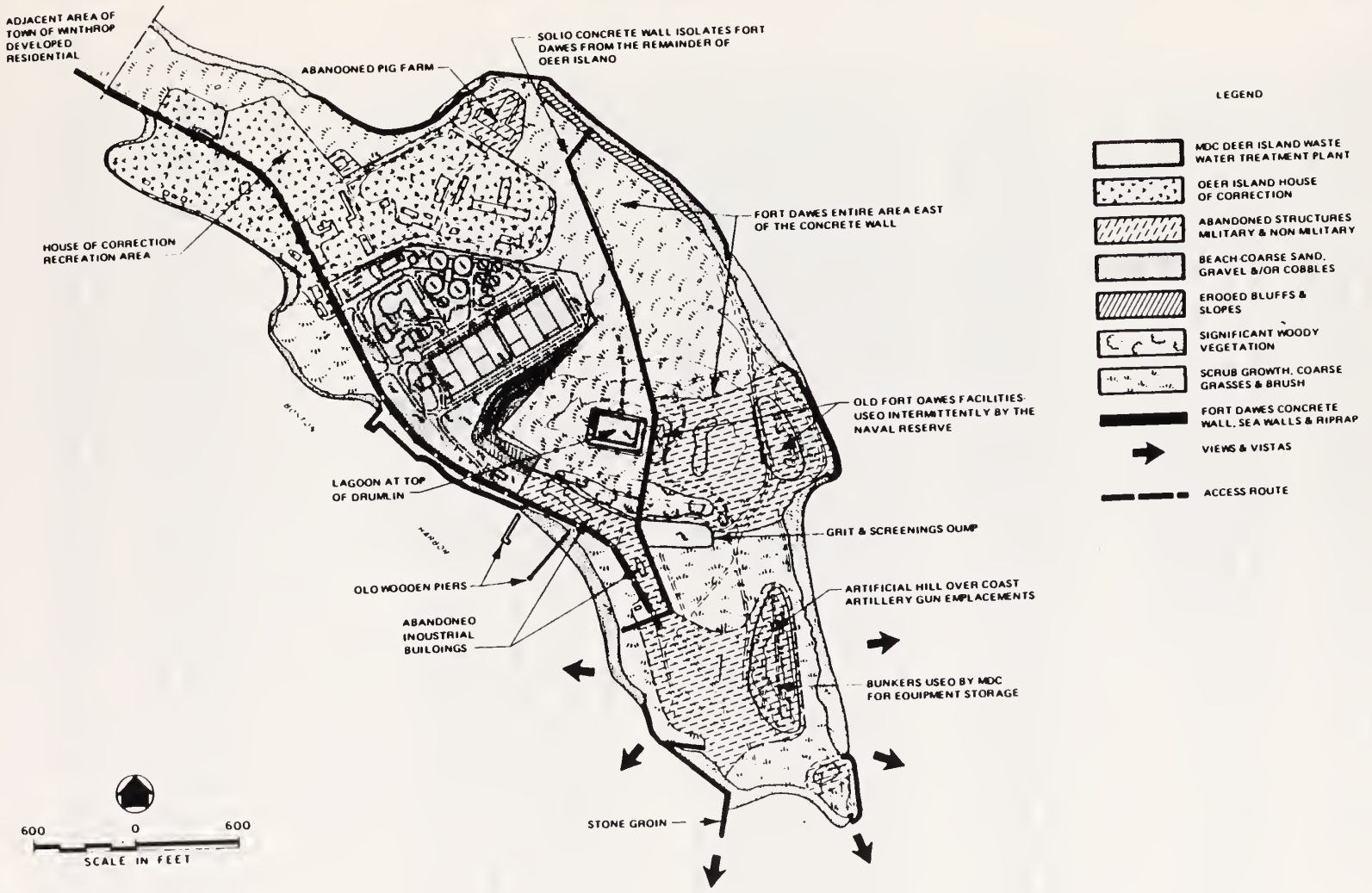
Figure 5.2.5-1 depicts the existing conditions on Deer Island. Deer Island, connected to the southern tip of Winthrop, is 203 acres in size. The two active land uses are the Deer Island House of Correction, owned and operated by the City of Boston, and the MWRA's existing 343 mgd primary treatment facility for the North Service area. Combined, these facilities occupy a total of approximately 60 acres toward the landward side of the island. Except for the treatment plant and prison structures, almost all of Deer Island is open space with recreational use limited to prison recreation areas and passive recreational areas used by prison and treatment plant employees. Occasional visitors use the south end of the island for passive recreation.

Deer Island is zoned "B-1, General Business" by the City of Boston. This classification allows all commercial and residential uses, but excludes industrial or other nonconforming uses without a variance. The existing nonconforming uses of the prison and the treatment plant predate the zoning classification.

The Deer Island House of Correction has over 450 inmates, with over 4,000 visitors annually. House-to-house searches undertaken in the neighborhood and the use of sirens following prison escapes (20 during 1983) have aggravated neighborhood residents. Past concerns for the prison's problems and proximity to residential areas have led to local, state and federal efforts to relocate this facility. Applicable state law requires that the House of Correction be relocated by 1989.

Although a prison and a sewage pumping station have been located on Deer Island for nearly 100 years, it was after the hurricane in 1936 that these metropolitan uses on Deer Island began to be more closely associated with the Point Shirley neighborhood. Prior to this time, Shirley Gut and its swiftly moving currents physically separated Deer Island from Winthrop. Access was by ferry. Hurricane winds and tides deposited sand and silt that connected the Island to Winthrop. This was consolidated and made into a causeway permanently linking the two areas. Loss of the Gut reduced the flushing action around Deer Island and brought the island into closer association with the Town of Winthrop (even though Deer Island remained a part of the City of Boston).

The Point Shirley and Cottage Hill neighborhoods are the closest communities to Deer Island. They are situated on a narrow peninsula with Point Shirley connected to Deer Island and separated from Winthrop by a causeway. The neighborhoods are predominantly residential with approximately 450 residences and a population of about 1000 people in Point Shirley, and about 1400 residences and approximately 3400 people in Cottage Hill. A majority of the homes, originally built as summer cottages, have been winterized and are used on a year-round basis.


ADJACENT AREA OF TOWN OF WINTHROP DEVELOPED RESIDENTIAL
ABANDONED PIG FARM
SOLID CONCRETE WALL ISOLATES FORT DAWES FROM THE REMAINDER OF DEER ISLAND
FORT DAWES ENTIRE AREA EAST OF THE CONCRETE WALL
HOUSE OF CORRECTION RECREATION AREA
OLD FORT DAWES FACILITIES USED INTERMITTENTLY BY THE NAVAL RESERVE
LAGOON AT TOP OF DRUMLIN
GRIT & SCREENINGS DUMP
OLD WOODEN PIERS
ARTIFICIAL HILL OVER COAST ARTILLERY GUN EMPLACEMENTS
ABANDONED INDUSTRIAL BUILDINGS
BUNKERS USED BY MDC FOR EQUIPMENT STORAGE
STONE GROIN
600 0 600
SCALE IN FEET
LEGEND
MDC DEER ISLAND WASTE WATER TREATMENT PLANT
DEER ISLAND HOUSE OF CORRECTION
ABANDONED STRUCTURES MILITARY & NON MILITARY
BEACH COARSE SAND, GRAVEL &/OR COBBLES
ERODED BLUFFS & SLOPES
SIGNIFICANT WOODY VEGETATION
SCRUB GROWTH, COARSE GRASSES & BRUSH
FORT DAWES CONCRETE WALL, SEA WALLS & RIPRAP
VIEWS & VISTAS
ACCESS ROUTE

SOURCE: Metcalf & Eddy, June 1982

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.5-1**
**DEER ISLAND EXISTING CONDITIONS**

Most major commercial activity in Winthrop is located along the main truck route to Deer Island. Zoning in Point Shirley, Cottage Hill and throughout much of Winthrop is "Residence A, Single Family Use."

Areas surrounding Deer Island can be characterized as residential in Winthrop to the northwest, transportation oriented at Logan International Airport to the west, open/institutional on Long Island and the President Roads shipping channel to the south, and open water (Broad Sound and the Atlantic Ocean) to the north and east.

Visual Character

With an elevation at the summit of 210 ft., the drumlin is the dominant natural feature on Deer Island. Although it has been altered by activities related to the treatment plant and the military, it is still a prominent visual feature, defining and characterizing Deer Island from locations on-shore and in the Harbor.

A visual analysis of the Island was performed by Jung-Brannen Assoc. in 1986 as part of this study. It identified six visual zones within Boston Harbor -- the inner harbor, Dorchester Bay, Quincy Bay, Hingham Bay and two clusters of islands: Gallop, Lovells, George's Island and the Brewsters (Jung-Brannen, 1986). Two major gateways and three minor gateways to the Harbor were evident. Deer Island and Long Island frame the major Atlantic gateway to the outer harbor, while Logan International Airport and Castle Island frame the second major gateway between the inner and outer harbor. Nut and Peddock Islands create a minor gateway between Quincy Bay and Hingham Bay. The other two minor gateways do not impact the MWRA project area.

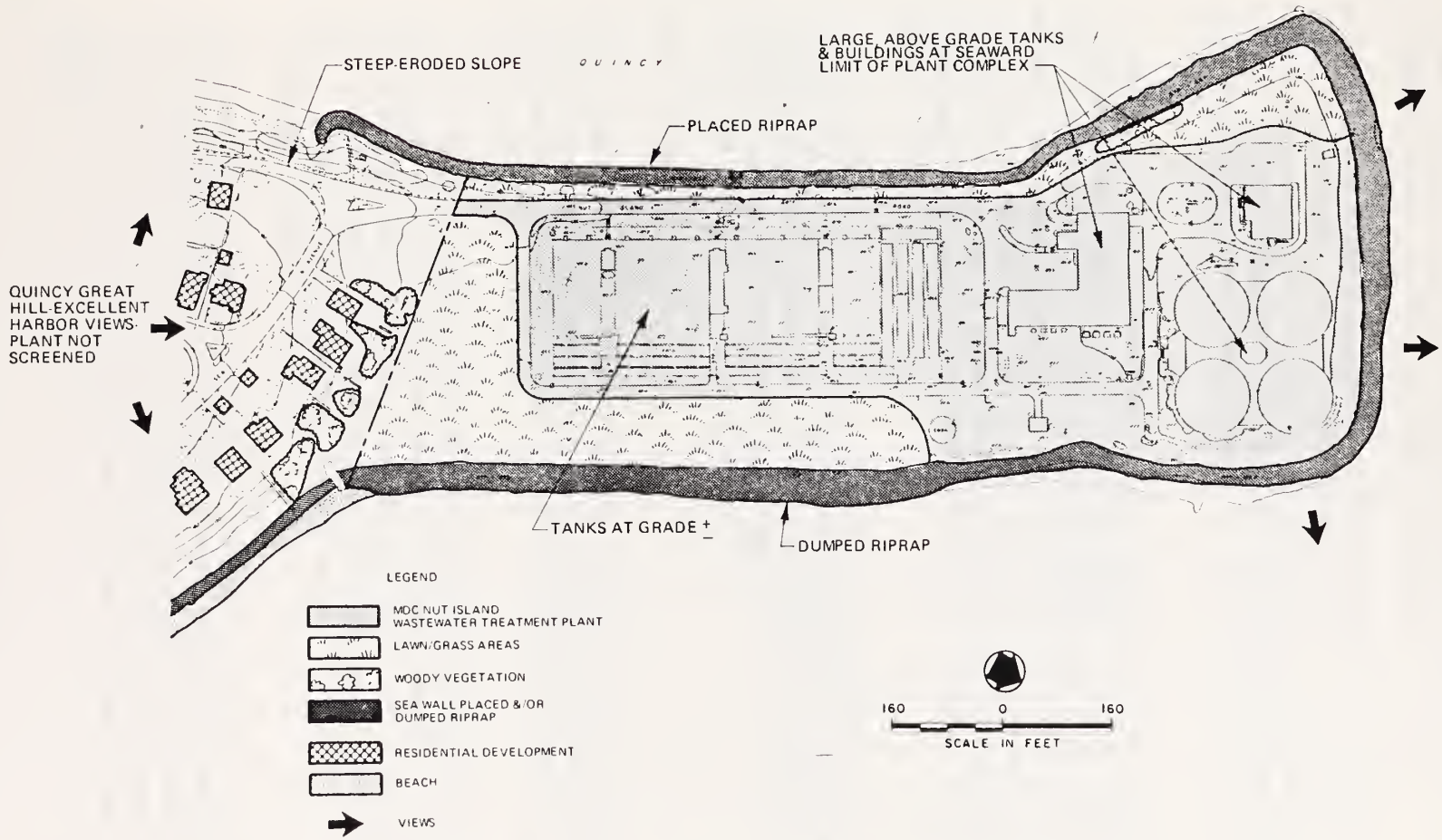
Based upon the identification of landmarks, zones of vision were drawn from the near and distant viewpoint landmarks. It was determined that near views to Deer Island were available from various places in Winthrop, Logan Airport, Castle Island, and the islands to the south, including Long Island. Distant views are available from the office towers of downtown Boston and Back Bay, the JFK Library in Dorchester, from the shores of Nahant, and from the point at Hull High School. From the water, three types of craft have views of the site: commercial ships in the main channels; passenger ferries that follow designated routes; and recreational craft that can view the site from several points.

Nut Island

Land Use

Nut Island is a peninsula located on the southern shore of Boston Harbor. Existing Nut Island topography is flat, with almost its entire 17 acre area lying between elevations 125 and 130 feet. The edge of this flat area is rip-rap which drops off steeply to the intertidal area.

Figure 5.2.5-2 shows the existing conditions at Nut Island. Nut Island is occupied exclusively by structures associated with the primary treatment facility: tanks are situated at the




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.5-2**
**NUT ISLAND EXISTING CONDITIONS**

landward end of the site and major above-grade structures are situated at the seaward limit. The property has been recently rezoned by the City of Quincy as "Open Space".

While the island is entirely open, there is no significant vegetation on Nut Island or on the fill area which connects it to the mainland below Hough's Neck. A majority of the property is either covered with concrete or blacktop. Consequently, the area is only occasionally used for recreation by children during the summer or by adult parking at the north end, apparently taking advantage of the harbor view. Figure 5.2.5-3 shows the relationship between Nut Island and Hough's Neck.

Nut Island adjoins the residential neighborhood of Hough's Neck, which is a peninsula forming the southeastern boundary between Quincy andd Hingham Bays. Hough's Neck is a densely developed residential area with some commercial development along its main streets. The housing in this area was originally built as summer residences; however, nearly all of the houses have since been converted for year-round use. Hough's Neck contains approximately 180 homes within one-half mile of the Nut Island treatment plant. The closest homes are only about 300 feet away. Population in Hough's Neck is estimated at approximately 4,000 persons. (CE Maguire, 1987).

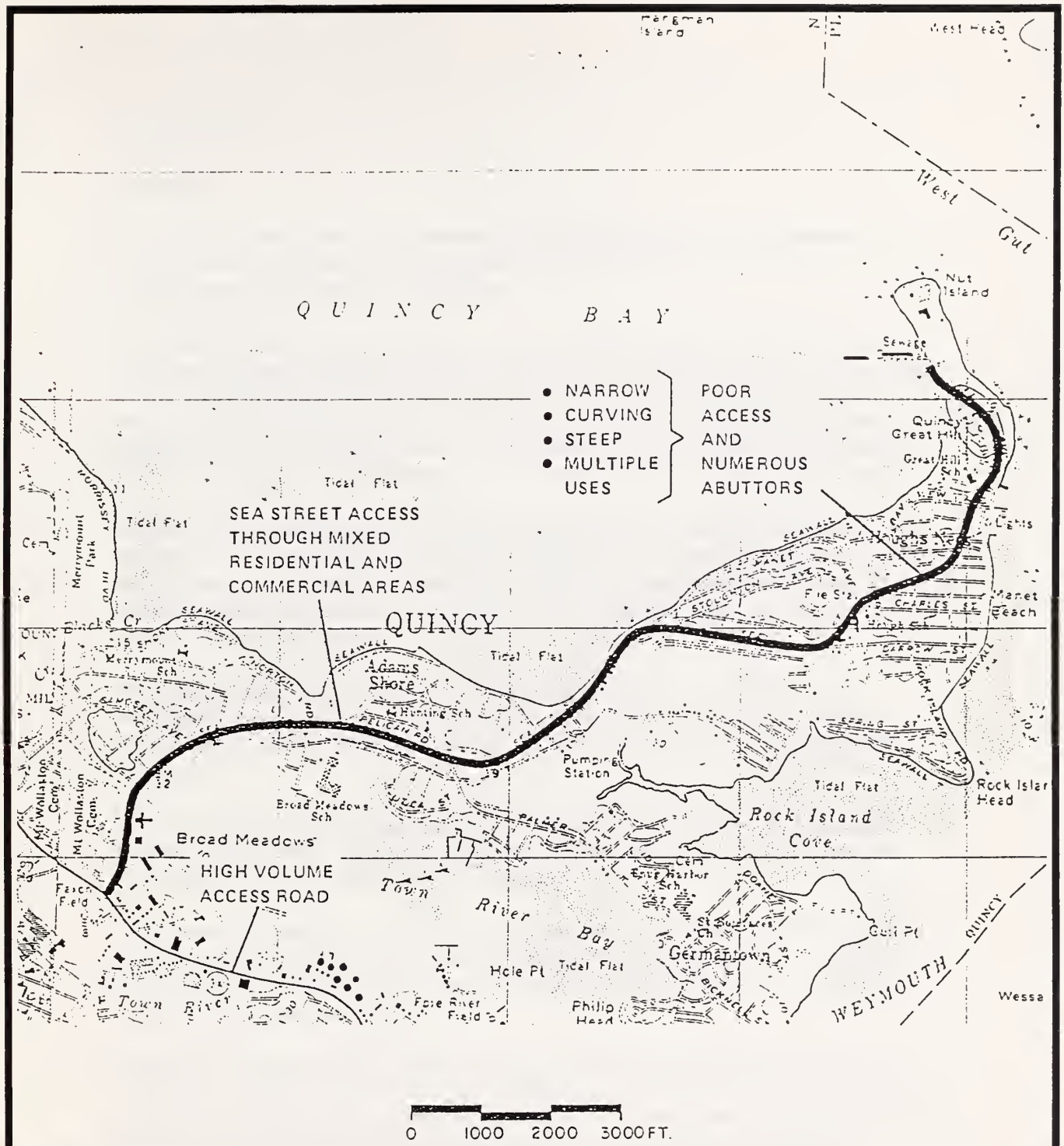
The chief attractions of the Hough's Neck neighborhood are its waterfront location, access to recreation, and views of the harbor. Neighborhood commercial uses, including food stores, restaurants, marinas and boat rentals are located along Sea Street, the major access route. Access for boating and fishing is provided by the Quincy Yacht Club and a boat rental business, both on Hingham Bay. (CE Maguire, 1987).

Visual Character

There are approximately 10 dwellings on the eastern shoreline of Hough's Neck on Quincy Great Hill with near views of the treatment facility. For these homes, the treatment plant is a primary focal point in the view and imposes a significant industrial character on an otherwise residential area.

On the shoreline west of Hough's Neck, approximately 20 houses are located at or near sea level and eight more have northwesterly views from 60 to 90 ft above sea level. Northeasterly views from the lower elevations are blocked by the treatment facility. The plant tends to blend in, however, with the general developed character of Hough's Neck as one continues to look toward the east. A majority of the harbor view from these locations is unaffected by the existing treatment plant. (Metcalf & Eddy, 1982).

The operation of the wastewater treatment plant on Nut Island has been a source of problems for residents of Hough's Neck. The discharge of unscreened and untreated sewage from the plant is a recurring problem for local residents and those using the shoreline and harbor areas around the treatment plant. Odors emanating from the plant are not a problem, at present. However, the temporary use of emergency generators has led to noise complaints from nearby residents in the past.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.5-3**
**ACCESS ROADWAYS TO NUT ISLAND**

## 5.2.6 TRAFFIC

### Deer Island

Land access to Deer Island is by a causeway that connects the island to the mainland. The island is within the corporate boundary of Boston; however, access to the causeway is by local roads passing through the Town of Winthrop.

Figure 5.2.6-1 shows a map of Winthrop. Route 145 does not pass through the central part of town where the downtown business district and town hall are located, but rather circumnavigates it. The route provides general access from the north and west, over Bennington Street, Saratoga Street, Main Street, Pleasant Street, Washington Avenue, Veterans Road, Winthrop Shore Drive, Crest Avenue and Revere Street. On the western side, the crossing of Belle Isle Inlet leads to East Boston. On the northern side, a similar crossing leads to the town of Revere.

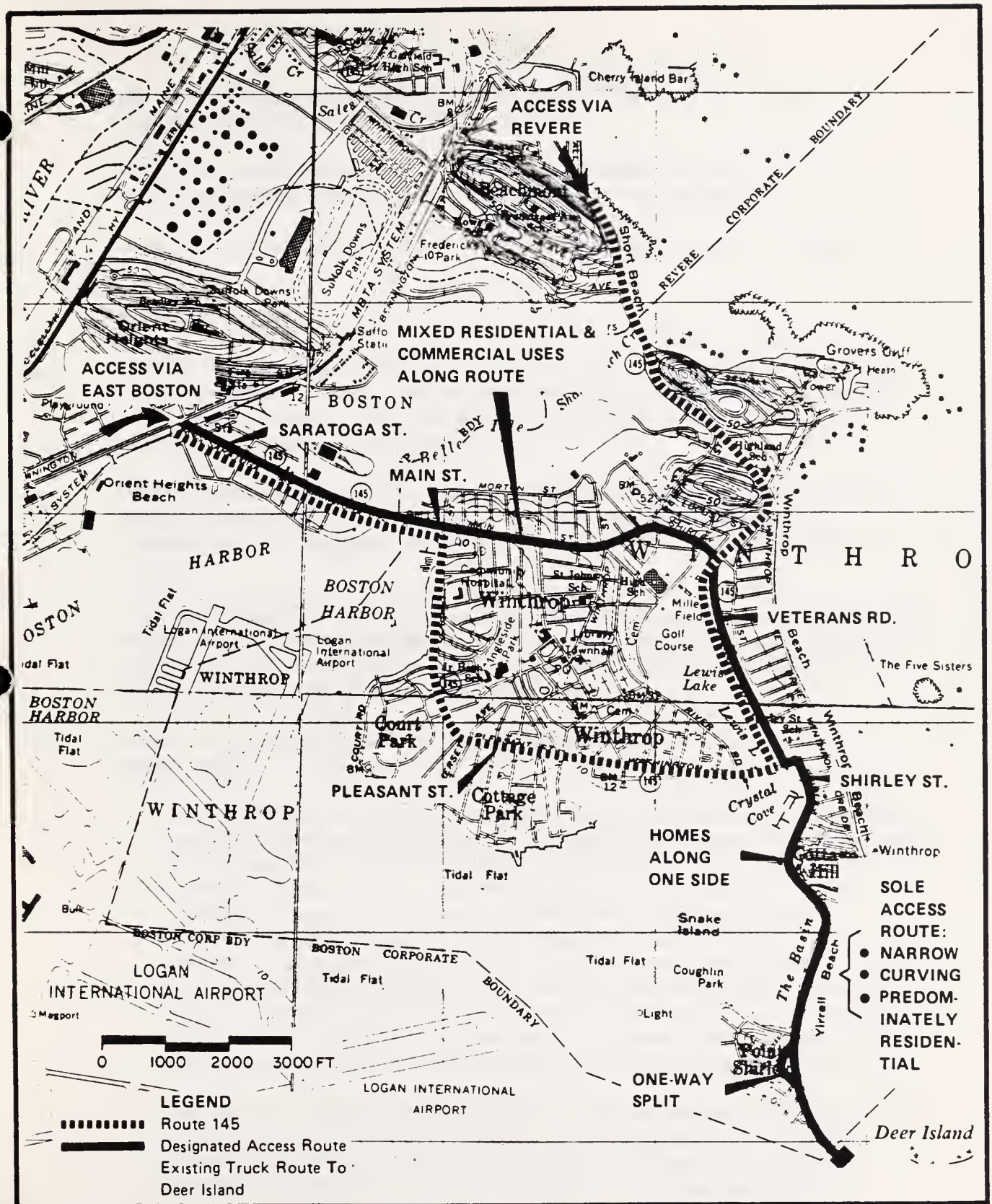
A truck route has been defined and is posted, requiring that truck movements into and out of Winthrop, and to Deer Island and back, use Bennington Street, Saratoga Street, Main Street, Revere Street, Shirley Street, Veterans Road, Washington Avenue and Shirley Street. This route also avoids passage through the town center. Current truck movements over the defined route often occur with police escort.

Restrictions affecting use of the truck route include load limits on the bridge carrying Sarratoga Street over the MBTA Blue Line. The bridge is currently limited to 2-axle trucks that are 13 tons or less, 3-axle trucks that are 20 tons or less and 5-axle trucks that are 33 tons or less.

Curbside parking is allowed along Main Street, Revere Street, Shirley Street and the lower section of Shirley Street. The entire truck route supports two-way traffic flow; no one-way routing has been used to achieve higher throughput.

Local roadways elsewhere in Winthrop are fairly narrow, and there are no restrictions on curbside parking. Observed vehicular movements are dispersed and irregular. Only rarely is traffic movement delayed while a moving vehicle enters the opposing lane to avoid a parking vehicle occupying the moving lane.

Observations of general traffic conditions in Winthrop have shown that vehicular speeds in Winthrop are between 20 and 30 mph and appear to be a matter of local habit and preference rather than a result of deliberate enforcement policies. Observed speeds over the entire truck route are moderate, serving to reduce congestion and preserve safety along the route.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.6-1**
**ACCESS ROADWAYS TO DEER ISLAND**

Average two-way daily traffic (ADT) ranges from 1,700 to 7,700 vehicles (CE Maguire, 1987). The design traffic flows range from 100 to 650 vehicles.

Analysis of ten intersections located in Winthrop shows that effective capacities range from 2500 to 5500 vehicles; existing traffic volumes range from 1475 to 5475 vehicles.

A more complete discussion of existing Winthrop traffic conditions is contained in Appendix K.

Nut Island

Access to Nut Island is via Sea Street from the Southern Artery of Route 3A as shown in Figure 5.2.5-3. Sea Street is a two-way four-lane roadway that connects Houghs Neck to the City of Quincy via Adams Shore. All traffic to and from Nut Island must use local roads passing through Quincy, Braintree and Weymouth.

From Sea Street, Sea Avenue provides access to Nut Island over Quincy Great Hill. The Avenue ascends and descends the hill at a steep grade. Adjacent land is densely developed for residential use. A variety of commercial activities are located nearby, parking is allowed on the street.

Table 5.2.6-2 presents 1983 Average Daily Traffic Volumes (ADT) and Design Hour Volumes for locations where the Massachusetts Department of Public Works has obtained traffic counts. The table originally appeared in the supplemental draft environmental impact report (DEIR) on Siting of Wastewater Treatment Facilities for Boston Harbor.

The following describes how the design hour volumes and road capacity were estimated (CE Maguire, 1984).

> The capacity and Level of Service for the major roadways in the study area were determined from capacity tables in the Highway Capacity Manual (Highway Research Board, Special Report #87, Washington, D.C., 1965). It has been established that a "D" Level of Service provides acceptable operating conditions for an existing roadway facility. Under this classification level traffic is considered to experience some slight delays and speed reductions. The Highway Capacity Manual indicates that a four lane roadway at a "D" Level of Service can accommodate 2800 vehicles per hour on two lanes in one direction. Assuming that 70% of the design hour volume (DHV) occurs in the direction of peak flow, the current one-way peak hour flow on Sea Street west of Quincy Shore Drive, for example, would be 1,925 vehicles (70% of 2,750). Since two lanes in one direction can accommodate 2800 vehicles, the existing traffic can be accommodated on the existing 4-lane roadway system.
>
> According to the Highway Capacity Manual, the two lane, two-way portion of Sea Street has a capacity of 1600 vehicles for both directions of travel. The existing DHV through this section of the access route is 600 vehicles per hour. This indicates that there is more than sufficient capacity on Sea Street for existing traffic. The above table indicates

TABLE 5.2.6-1

TRAFFIC COUNT RECORDS IN THE VICINITY OF NUT ISLAND*

| Location | Lanes | ADT | Two-Way* DHV | One-Way DHV | One-Way Capacity* |
|---|---|---|---|---|---|
| Quincy Shore Drive | 4 | 24,150 | 1,950 | 1,365 | 2,800 |
| Sea St., west of Quincy Shore Drive | 4 | 34,300 | 2,750 | 1,925 | 2,800 |
| Sea St., east of Quincy Shore Drive | 4 | 20,400 | 1,650 | 1,115 | 2,800 |
| Sea St., east of Rockland St. -- Winthrop St. | 2 | 7,350 | 600 | -** | ***1,600 |
| Southern Artery south at Sea St. | 4 | 32,700 | 2,600 | 1,820 | 2,800 |
| Sea St. at Southern Artery | 4+ | 36,850 | 2,950 | 2,065 | 2,800 |

* Source: Highway Capacity Manual, 1965.
** Use Two-Way DHVB figure for comparison
***Two-Way Capacity

that all of the major local access roads have excess peak hour capacity to accommodate present traffic flows.

Construction traffic impacts to Quincy and surrounding area have been addressed in the Final Environmental Impact Report(s) for On-Island and On-Shore Water Transportation Facilities (1987). Included in these studies are traffic assessments of Sea Street and Sea Avenue.

### 5.2.7 NOISE

Noise associated with the construction and operation of the new Deer Island secondary wastewater treatment plant, and at headworks facilities on Nut Island, has the potential for impacting portions of the Town of Winthrop and Quincy. To minimize noise impact, noise control requirements will be incorporated into the treatment plant facilities planning process through the use of noise evaluation criteria. These criteria will be employed to judge the effectiveness and acceptability of noise controlling alternatives as they apply to wastewater treatment equipment, site planning, and construction. The existing regulatory and environmental factors that constitute the basis for developing the noise evaluation criteria are summarized in this section.

Regulatory criteria that address noise control, as well as assessments of potential impacts, rely on evaluations of baseline noise levels for judging the magnitude and acceptability of incremental noise changes. Several baseline noise surveys have previously been made within the Point Shirley and Nut Island study areas. These surveys sampled ambient noise for periods of a few minutes up to 24 hours.

This section characterizes existing noise within the study areas, and describes a more extensive study that was conducted during this facilities plan to provide a firm statistical basis for the development of recommended noise criteria for Deer Island and Nut Island. The results of this and previous surveys, and recommendations for construction and operational noise criteria, are summarized herein.

#### Regulations and Guidelines

The assessment of noise impact involves determining both the increase in ambient noise and compliance with appropriate regulations. Three noise regulations are potentially applicable to the Deer Island site. These are the City of Boston Noise Regulations, the Massachusetts Department of Environmental Quality Engineeering (DEQE) guidelines, and U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) standards. The latter two regulations are also applicable to Nut Island. These regulations are summarized as follows:

The City of Boston's noise regulations address various sources of noise and set specific noise limits for the transmission of sound between properties of the same and different zoning. The allowable noise transmitted to a residential zone during the daytime hours of 0700 to 1800 (7:00 a.m. to 6:00 p.m.) is 60 dBA. A 50 dBA level is allowable during the remaining nighttime

hours. The maximum noise allowed to be transmitted to an industrial site is 70 dBA. The code also has corresponding octave band level requirements.

The Boston noise code limits construction noise at the residential and institutional property lines to an L10 (the level exceeded 10 percent of the time) of 75 dBA and a maximum level of 86 dBA. The allowable L10 for recreational land is 80 dBA. Construction is not permitted at night or on weekends unless the construction noise level at the residential property line does not exceed 50 dBA.

The State of Massachusetts Department of Environmental Quality Engineering (DEQE) guidelines on noise allow a new facility to increase the ambient noise a maximum of 10 dBA over the existing L90 ambient noise, i.e. the level exceeded 90 percent of the time. The L90 levels to be used have been based on sorting daytime and nighttime measurements, to yield daytime and nighttime criteria. The DEQE guidelines also prohibit the emission of a pure tone from noise sources. A pure tone is defined as occurring when the level in one octave band exceeds the level in the two adjacent octave bands by 3 dB or more.

All equipment on the site will be required to conform to the OSHA requirements on noise exposure. These regulations allow an equivalent 8-hour exposure of 90 dBA for the protection of employee hearing. Where equipment cannot be purchased to meet OSHA noise exposure requirements, noise mitigation must be added as required.

Previous Ambient Sound Level Surveys

At least five previous ambient sound level surveys associated with the Deer Island treatment facilities have been conducted in the Deer Island area. These surveys are summarized in Table 5.2.7-1. The surveys collected statistical sound level samples of a few minutes to an hour in duration, and in one instance, 24 hours. Measurements were usually collected at several locations. These measurements were used for making preliminary assessments of anticipated noise impact for the facility.

However, as part of secondary treatment facility planning and environmental reviews, a more extensive data base was desired. Ambient noise is a statistical quantity which not only varies diurnally, but also from day to day. Both the perceived noise impact and the allowable level as required by the DEQE are based on an assessment of the existing ambient sound level. A sampling program which continuously monitored ambient sound levels 24 hours a day for a total of 17 days was conducted. This large sample of ambient sound levels provides a broad base for assessing the existing ambient levels.

Two ambient sound level surveys have been conducted in the Nut Island treatment plant area. Data from these surveys have been used to assess the noise impacts expected from the construction and operation of the new facility, as described later in this section.

TABLE 5.2.7-1

SUMMARY OF PREVIOUS AMBIENT SOUND LEVEL SURVEYS
CONDUCTED IN WINTHROP FOR THE WASTEWATER TREATMENT PLANT

| CONDUCTED BY | DATE | REPORTED IN |
|---|---|---|
| Metcalf and Eddy | 1982 | Site Options Study, Vol. II 1982. |
| Havens and Emerson | 4-3-84 | Supplemental Draft Environmental Impact Statement/Report on Siting of Wastewater Treatment Facilities for Boston Harbor. Vol. 2. |
| Thibault and Bubly Associates | 6-12-85 | Noise Analysis (To EPA). |
| Cavanaugh Tocci Associates | 9-11-85<br>9-25-85 | Supplemental Draft Environmental Impact Statement/Report on Siting of Wastewater Treatment Facilities for Boston Harbor. Vol. 2, Appendix. |
| C.E. Maguire, Inc. | 7-1-86 | Notice of Project Change, On-Island Water Transportation Facilities, 7-31-86. |

Ambient Sound Level Survey

For this study, an ambient sound level survey was conducted at Point Shirley, in the Town of Winthrop, as the nearest area potentially impacted by facility construction and operation noise. The goals of the survey were to:

1) Establish the spatial variation in the ambient sound levels throughout Point Shirley.

2) Establish the diurnal variation in the sound levels.

3) Determine the temporal variability of sound levels from day to day.

4) Identify the sources of noise controlling these levels.

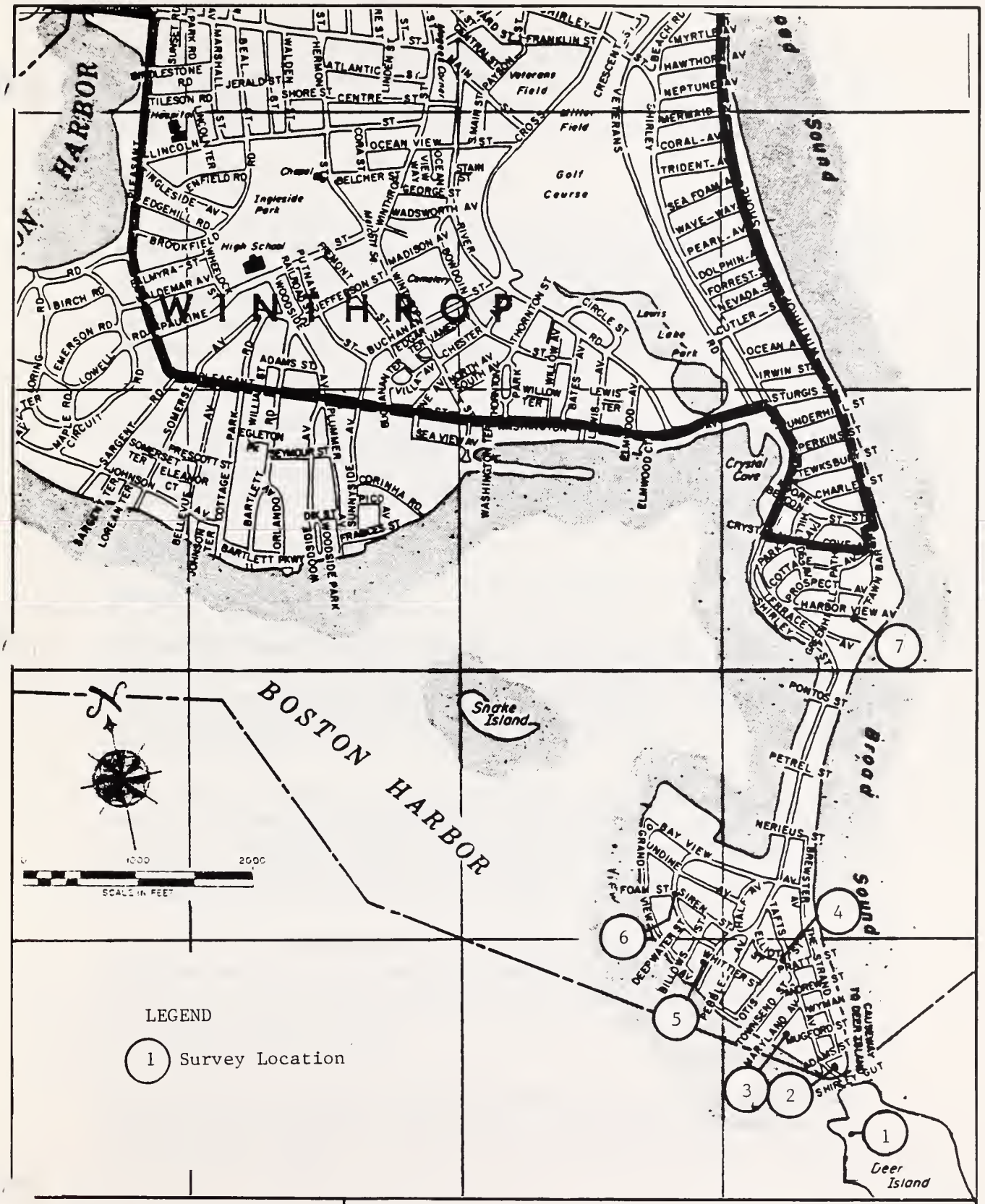
Measurement Locations and Methodologies

A preliminary inspection of the study area indicated that the primary noise sources were Logan Airport, traffic on Tafts Street and other local roads, surf noise from the beaches, and occasionally the existing treatment plant. Previous studies also indicated that the Nordberg diesel drives on the existing wastewater pumps were sometimes audible. These previous studies also assessed the sound levels throughout Winthrop and concluded that the mainland portion of Winthrop had nighttime L90 levels in the 34 to 40 dBA range, whereas Point Shirley was slightly louder, in the 40-43 dBA range. Since the distance to the other parts of Winthrop are greater, the criteria selected for Point Shirley will also serve as conservative criteria for the balance of Winthrop.

Measurement locations were selected to provide data on each of the sources discussed in the previous paragraph, as well as to be spatially distributed across Point Shirley. A map of the locations is given in Figure 5.2.7-1. All of the locations except No. 1 have line-of-sight shielding by houses from the airport and surf. Location 1 was shielded by a house from the diesel pump station. Locations 2 and 3 had line-of-sight visibility to the diesel pump station.

Two types of noise survey methodologies were utilized which, when used in conjunction with each other, provide a complete description of the spatial and temporal variation in sound levels. The first type consisted of the continuous statistical monitoring of sound level sequentially at locations 1 and 3, shown in Figure 5.2.7-1. A total of 17 data days were taken sequentially at these locations. Locations close to the plant were selected for the continuous monitors because the potential for noise impact is the greatest close to the site. The monitor was periodically calibrated throughout the survey.

The second type of survey was staffed, and measurements were taken with portable instrumentation. During these surveys, 10-minute statistical samples of sound level data were always taken, and on three out of five of the surveys, residual octave band measurements were




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.7-1**
**AMBIENT SOUND LEVEL SURVEY MEASUREMENT POSITIONS, WINTHROP MASSACHUSETTS, SEPTEMBER 1986**

also taken. The staffed surveys enable a number of locations to be measured in a relatively brief period of time along with observations of the sources of noise. The staffed surveys were conducted during 2- to 3-hour periods during the day and night at locations 1, 2, 4, 5, 6, and 7. The staffed survey results are given in Appendix C, Tables C-1 through C-5.

Instrumentation

Two types of instruments were used for measuring the ambient sound levels. A Larson-Davis 800 Noise Analyzer and a Bruel and Kjaer 2215 sound level meter were used manually to measure residual octave band sound pressure levels and A-weighted sound level statistics. The residual octave band measurements are taken in the absence of transient noise such as passing vehicles and aircraft landings. Ten-minute statistical samples of the A-Weighted sound level were taken by reading the meter every 10 seconds and preparing a histogram of the data. All manual measurements were taken with local winds less than 10 mph.

The second type of instrument used was a Larson-Davis 700 Noise Dosimeter, which continually measures and statistically analyses the variable ambient noise. The device was programmed to provide hourly statistics including the L10, L50 and L90 values. The L90 value typically represents the residual or background level which occurs when transient noise is absent.

Survey Results and Discussion

Manually Collected Data

The manually-collected data discussed above for Point Shirley is presented in Appendix N, Tables N-1 through N-5. Most of the L90 sound level data taken some distance from the water (locations 4, 5, and 6) were determined to be in the 42-47 dBA range. Measurements taken from locations that are more exposed to surf noise, such as locations 1, 2, 3, and 7, were sometimes several decibels higher.

During the day and evening, the quiet intervals between aircraft takeoff and landing noise were observed to be infrequent and brief. However, after the hours of approximately 2300 to 2400 (11:00 p.m. to midnight), takeoffs and landings became infrequent and the residual levels appeared to be controlled by surface aircraft operations at Logan Airport, surf noise, and occasionally the Nordberg diesels of the treatment plant wastewater pumps.

In general, the more sheltered locations, i.e. those away from the shore, were 5 or 6 dBA quieter than those near the water because they were partially shielded from Logan ground operations, surf, and occasional diesel noise. This was directly observed in the field by measuring noise primarily from surface aircraft operations, and then moving behind a house to block the line of sight to the airport.

The pump station diesels were inaudible at all locations when the winds were northerly. This is because the vertical gradient in wind speed tends to raise the upwind sound wave off the ground and creates a shadow zone. However, when the winds had a southerly component, i.e. from

the direction of the diesels, the diesels were occasionally audible at one or two measurement locations which varied from survey to survey. Diesel audibility is indicated in Appendix N, Tables N-1 to N-5.

When audible, the diesel sound varied in an irregular, pulsing manner caused by multiple diesel units operating at slightly different speeds. Most of the diesel noise was in the 63 Hz octave band corresponding to the cylinder firing rate. At one of the measurement locations the diesels caused a 4 dBA variation in the sound level on "fast" response. The level in the 63 Hz band on "fast" response varied from 5-10 dB. On "fast" response the meter's response time is reduced and the meter becomes very sensitive to rapid changes in sound level. All other measurements were taken on "slow" response as is standard practice for community noise measurements.

Continuous Monitor Data

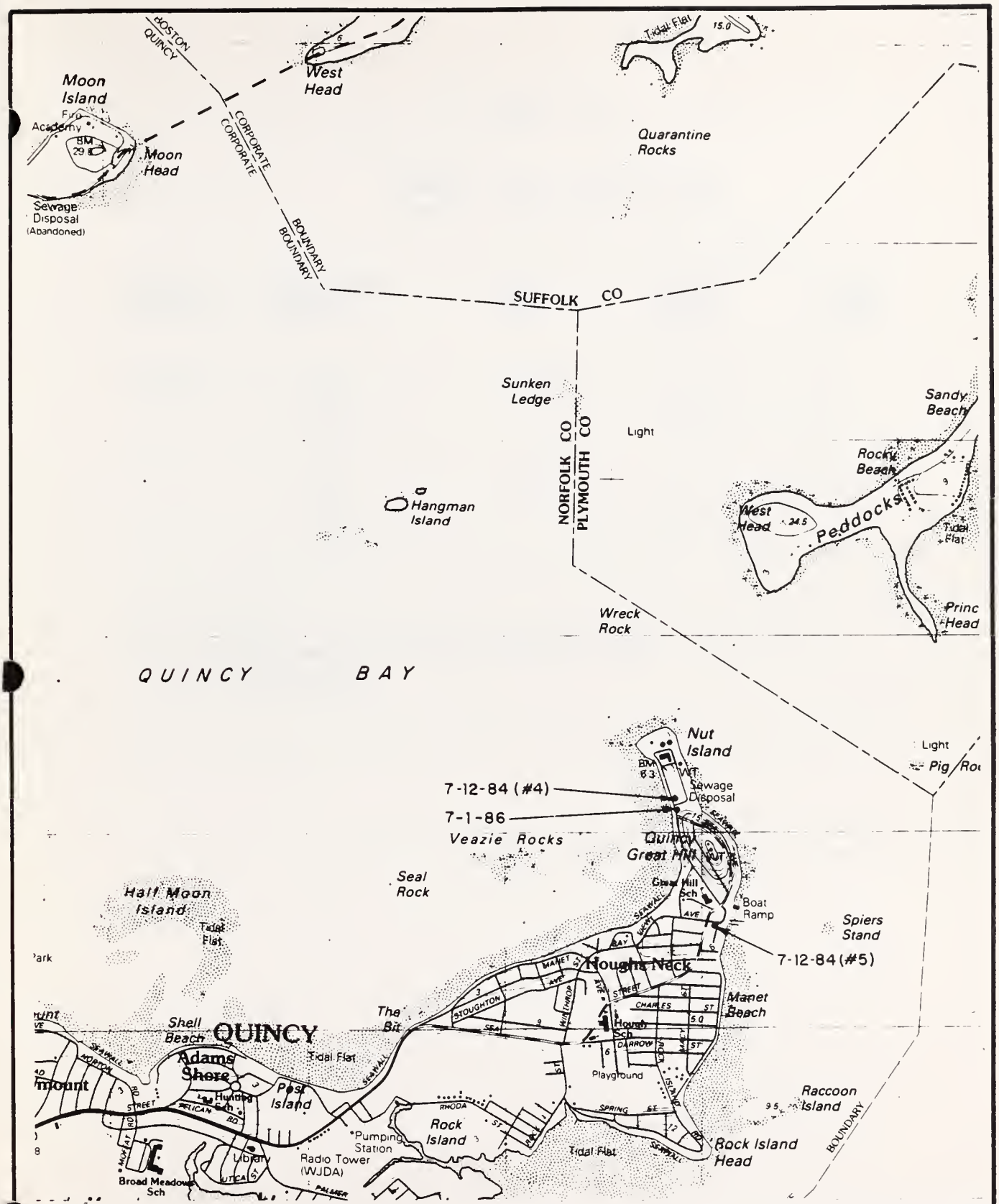
A tabulation of the data from the continuous monitor used first at Location 1 and then at Location 3 is given in Appendix D. This data describes the diurnal variation in sound level for 13 days at Location 1, and 5 days at Location 3. The data from the two locations are very similar and are analyzed together.

The L90 data were divided into meaningful time periods and sorted to examine the group statistics. The L90 sound levels for the nighttime period of 2300 to 0600 (11:00 p.m. to 6:00 a.m.) were grouped together and sorted to determine their percentiles of exceedence. During this period of time, it is likely that a significant percentage of the population would be sleeping.

This analysis indicates that, during 50 percent of the time, the nighttime L90 values were greater than 45 dBA, indicating that 45 dBA is a typical value for the nighttime L90 sound level. The 90 percentile value of the L90 sound level at that location exceeds 39 dB. The lowest hourly L90 measured was 35 dBA at location 1.

A similar analysis was performed for the daytime hours of 0700 to 1800 (9:00 a.m. to 6:00 p.m.). This time period includes the most common periods of construction. The quietest hour during this period was at 41 dBA. However, 90 percent of the time the L90 levels were in excess of 45 dBA, and 50 percent of the time they exceeded 51 dBA. These measurements generally agree with the previous shorter-term assessments on noise on Point Shirley.

As indicated previously, two ambient sound level surveys have been conducted in the vicinity of Nut Island. The first noise survey was conducted on July 12, 1984 by CE Maguire. This survey was previously reported in the SDEIR. The second survey was also conducted by CE Maguire and reported in their pile driving analysis. A map of the ambient measurement locations for both surveys is given in Figure 5.2.7-2 and a summary of the data is tabulated in Tables 5.2.7-2 and 5.2.7-3.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.2.7-2**
**DAYTIME BACKGROUND NOISE SAMPLING LOCATIONS ON NUT ISLAND**

TABLE 5.2.7-2

AMBIENT NOISE LEVELS IN THE VICINITY OF NUT ISLAND, 1986[1]

| PROJECT LOCATION | MEASURED STATISTIC | START TIME | SOUND LEVEL | START TIME |
|---|---|---|---|---|
| Nut Island | L90 | 10:38 am | 49 | -- |
| | L10 | | 53 | -- |
| | Leq[2] | | 52 | -- |
| | L90 | 2:45 pm | 47 | 1:30 pm |
| | L10 | | 55 | |
| | Leq | | 56 | |

[1] From pile driving analysis, C.E. Maguire to MWRA, 7-14-86
[2] Energy average sound level

TABLE 5.2.7-3

AMBIENT NOISE LEVELS IN THE VICINITY OF NUT ISLAND[1]

| SITE | L10 | L50 | L90 | Leq |
|---|---|---|---|---|
| 1. Houghs Neck - Nut Island Gate | 56 | 55 | 54 | 55 |
| 2. Houghs Neck - Sea St. | 59 | 54 | 52 | 56 |
| 3. Adams, Shore, Quincy - Sea St. | 68 | 64 | 58 | 65 |

[1] A-weighted sound pressure levels, recorded by CE Maguire, Inc. during mid-morning and afternoon of 7/12/84

The L90 sound levels from the July, 1984 survey were 52 and 54 at measurement locations 4 and 5. The L90 sound level was again measured on July 1, 1986 in the morning and in the afternoon at 49 and 47 dBA, respectively. The sampling period was 20 minutes.

Recommended Criteria

Two noise assessment criteria are required: one for assessing the noise from daytime activities such as construction and operation of the facility; and one for assessing the nighttime operation of the facility. These criteria differ because the ambient sound level changes from day to night.

The nighttime L90 sound level is generally used to assess nighttime noise impact. However, when a large sample of L90 data is collected, it becomes necessary to statistically select a representative L90 value. In order to be conservative, the 90 percentile value of the nighttime L90 values was selected for assessing nighttime noise impact. In other words, 90 percent of the nighttime L90 values exceed this value.

It is recommended that 39 dBA be used to assess the maximum nighttime noise impact at the property line. Other portions of Winthrop are much further in distance from Deer Island, and will receive adequate protection with this same criterion. This would also result in a DEQE requirement of 49 dBA for the allowable 10 dBA above ambient stipulated in Massachusetts DEQE Regulation 10 of the Air Pollution Regulations. It is not suggested that a 49 dBA level is the design goal, but rather that this level is a legal requirement that the site must, and will, meet as a maximum.

In a similar manner, the criterion for assessing daytime noise impact was determined to be 45 dBA. Since the lowest ambient noise levels occur during the middle of the day and the middle of the night, the maximum impact assessment criteria remain essentially the same during the evening as during the day.

The daytime ambient L90 sound levels taken on Nut Island ranged from 47 to 54 dBA. The quietest of these measurements, the 47 dBA collected in July 86, has been used as the ambient sound level criterion for assessing daytime construction noise impact at Nut Island. The continuous operation noise is expected to be sufficiently low so as not to cause an impact. The 47 dBA daytime criterion for Nut Island is very similar to the 45 dBA criterion developed for Deer Island. Nighttime noise measurements have not been reported for Nut Island; for these analyses a nighttime ambient sound level of approximately 35 dBA has been assumed, based on typical suburban residential areas (EPA, 1974).

In summary, the ambient sound levels (L90) for assessing maximum nighttime and daytime noise impact in the Point Shirley area are 39 and 45 dBA, respectively, as shown in Table 5.2.7-4. Predicted construction and operation noise will be compared with these levels in future analyses to determine the need for noise mitigation. The DEQE level not to be exceeded for constant nighttime operation noise is 49 dBA.

TABLE 5.2.7-4

SUMMARY OF RESIDUAL SOUND LEVELS,
POINT SHIRLEY, TOWN OF WINTHROP

| | L90 |
|---|---|
| Daytime<br>0700-1800<br>(7:00 a.m. - 6:00 p.m.) | 45 dBA |
| Nighttime<br>2300-0600<br>(11:00 p.m. - 6:00 a.m.) | 39 dBA |

| | Criteria |
|---|---|
| DEQE nighttime operation noise limit, no pure tone | 49 dBA |
| DEQE daytime operation noise limit, no pure tone | 55 dBA |
| OSHA on-site 8 hour exposure limit | 90 dBA |

## 5.2.8 TERRESTRIAL AND AQUATIC ECOLOGY

### Deer Island

Descriptive information for Deer Island was derived from a review of literature pertaining to the Island and from site visits. Literature reviewed is listed in the references and as specific credits given in the text. Site visits were made by Stone & Webster ecologists in 1976 and again in 1986.

#### Site Conditions

Deer Island is a large island of about 203 acres, dominated by a large grass covered drumlin over 100 feet high (Figure 5.2.5-1). This drumlin, like many of the islands in the harbor, is a geological formation resulting from the accumulation of till, clay and other materials flushed from beneath the ice sheets of 10,000 years ago. Prior to European settlement, the island probably had a community of deciduous forest, with stands of pines also common (Metcalf & Eddy 1982). Because of the relatively isolated nature of the island site, and its exposure to wind and sea salt, any change in the nature of the ecosystem takes a long time to repair itself. Thus, the historical land uses of the site have drastically altered the native vegetation. The present conditions tend to favor communities which form as a fire subclimax (Metcalf & Eddy 1982). These conditions include:

- Topography that favors rapid drying
- Regeneration from undamaged underground plant parts
- Porous soil
- Seeds enclosed within fire resistant woody fruits.

#### Flora

A majority of the present day site is either used for urban (commercial/institutional) activities or is covered with a scrub growth of coarse grasses and brush (Figure 5.2.5-1). The northwest portions of the island are primarily occupied by the existing waste treatment plant and are vegetated, if at all, by scattered grasses and forbs.

Scrub areas along the western side of the island to the south of the sewage treatment plant are primarily old fields dominated by ragweed (Ambrosia artemisifolia). In the low, damp areas, ragweed exceeds 1.5 meters in height. Wild carrot (Daucus carota), chicory (Cichorium intybus), and goldenrod (Solidago spp.) are also abundant. Along the concrete wall, field bindweed (Convolvulus arvensis), common tansy (Tanacetum vulgare), dwarf cinquefoil (Potentilla canadensis), snowy campion (Silene nivea) and bittersweet (Solanum dulcamara) are common.

North-northwest of the old pumping station, the slope rises steeply. The growth in this area is approximately one meter high and dominated by grasses. Ragweed, wild carrot and

The slope above the pumping station is an abandoned orchard, dominated by apple (Pyrus sp.), black cherry (Prunus serotina) and staghorn sumac (Rhus typhina). On the central and southern sections of the island is an old field dominated by unidentified grass species (Gramineae). Rabbit's-foot clover (Trifolium arvense), daisy fleabane (Erigeron sp.), common burdock (Arctium minus), milkweed (Asclepias sp.) and bouncing bet (Saponaria officinalis) were also present. This area also contains scattered clumps of trees of diverse mixtures including black cherry, Indian bean (Catulpa sp.), quaking aspen (Populus tremuloides), cottonwood (Populus deltoides), sugar maple (Acer sacchrum) and others.

To the east of the Fort Dawes concrete wall, the island is primarily grassland. The area contains scattered shrubs such as bayberry (Myrica pensylvanica), in occasional clumps with giant reed (Phragmites sp.) in the low areas.

Fauna

The varied nature of the site presents an equally varied habitat for wildlife species. On the west slope of the drumlin, the old field vegetation and the clumps of pioneer tree species all present sufficient cover and forage for numerous bird and mammal species.

Mammals - Reconnaissance of the island revealed that a number of mammals frequent the area. Cottontail rabbits (Sylvilagus sp.) and striped skunk (Mephitis mephitis) have been observed on the island (Table 5.2.8-1). Raccoons (Procyon lotor) and numerous rodents have been found on the island (Boston Harbor Comprehensive Plan 1972).

Birds - A number of bird species have been observed on the island (Table 5.2.8-1). Pheasant (Pasianus colchicus), red-winged black bird (Agelaius phoeniceus), bluejay (Cyanocitta cristata), plovers (Charadriidae), herring gulls (Larus argentatus), great black-backed gulls (L. marinus), swallows (Hirundinidae), and crows (Corvus brachyrhynchos) were observed on the island. Of particular note was the sighting of three sparrow hawks (Falco sparverius) hunting over the island. The presence of three raptors in the area suggests the presence of ample game in the form of insects and rodents (S&W Mgt. Cons. 1976). Reptiles and Amphibians - Few or no amphibian or reptile species are expected to inhabit the island because of lack of suitable habitat.

Endangered and Threatened Species

No endangered or threatened species are known to inhabit Deer Island. The US Department of Interior (USDI) list of species protected under the Endangered Species Act of 1973, as amended, contains only four species of terrestrial vertebrates whose geographic range includes Massachusetts (USDI 1986).

## TABLE 5.2.8-1

## LIST OF FLORA AND FAUNA OBSERVED AT DEER ISLAND

### WOOD SCRUB

| Type | Scientific Name | Common Name | Occurrence* |
|---|---|---|---|
| Trees | Pyrus sp. | Apple | Abundant |
| | Prunus serotina | Black cherry | Abundant |
| | Prunus sp. | Cherry | Common |
| | Catalpa sp. | Indian bean | Infrequent |
| | Rhus typhina | Staghorn sumac | Common |
| | Rhus glabra | Smooth sumac | Common |
| | Populus tremuloides | Quaking aspen | Infrequent |
| | Populus grandidentata | Bigtoothed aspen | Infrequent |
| | Populus deltoides | Cottonwood | Infrequent |
| | Acer sacchrum | Sugar maple | Infrequent |
| | Acer rubrum | Red maple | Infrequent |
| | Crataegus sp. | Hawthorn ** | Infrequent |
| Shrubs and Vines | Rubus canadenisi | Blackberry | Common |
| | Vitis sp. | Grape | Infrequent |
| | Asparagus sp. | Asparagus | Infrequent |
| | Rose sp. | Rose | Infrequent |
| | Myrica pensylvanica | Bayberry ** | Infrequent |
| | Spiraea sp. | Spirea | Common |

### OPEN FIELD

| | | | |
|---|---|---|---|
| Forbs | Daucus carota | Wild carrot | Abundant |
| | Ambrosia artemisiifolia | Common Ragweed | Abundant |
| | Solanum dulcamar | Deadly nightshade | Common |
| | Datuar strumonium | Jimson weed | Infrequent |
| | Solidago spp. | Goldenrod | Common |

Note: * Abundant - Frequently found, wide distribution
Common - Often found, scattered distribution
Infrequent - Seldom found, scattered distribution

** Old Field Vegetation

## TABLE 5.2.8-1

## LIST OF FLORA AND FAUNA OBSERVED AT DEER ISLAND (Continued)

| | | | |
|---|---|---|---|
| | *Cichorium intybus* | Chicory | Common |
| | *Tanacetum vulgare* | Common tansy | Common |
| | *Trifolium arvense* | Rabbit's foot clover | Infrequent |
| | *Potentilla canadensis* | Dwarf cinquefoil | Infrequent |
| | *Asclepias* sp. | Common milkweed | Common |
| | Gramineae | Grasses | Common-Abundant |
| | *Convolvulus arvensis* | Field bindweed | Common |
| | *Saponaria officinalis* | Bouncing bet | Common |
| | *Silene nivea* | Snowy campion | Common |
| | *Arctium minus* | Common burdock | Infrequent |
| | *Erigeron* sp. | Daisy fleabane | Infrequent |
| | *Petunia* sp. | Petunia | Infrequent |
| | *Solanum* sp. | Tomato | Infrequent |
| | *Linaria vulgaris* | Butter and eggs | Common |
| | *Phragmites* sp. | Giant reed | Common |
| **FAUNA** | | | |
| Mammals | *Sylvilagus* spp. | Cottontail rabbit | Common |
| | *Mephitis mephitis* | Striped skunk | Common |
| | *Procyon lotor* | Raccoon | Infrequent |
| | Rodentia | Mice and voles | Common-Abundant |
| Birds | *Agelaius phoeniceus* | Red-winged black bird | Abundant |
| | *Cyanocitta cristata* | Bluejay | Common |
| | *Corvus brachyrhynchos* | Crow | Common |
| | *Larus argentatus* | Herring gull | Abundant |
| | *Larus marinus* | Great black-backed gull | Common |
| | Hirundinidae | Swallow | Abundant |
| | *Charadrius* sp. | Plover | Common |
| | *Pasianus colchicius* | Ring-necked pheasant | Common |
| | *Falco sparverius* | Sparrow hawk | Common |

Mammals - The Indiana bat (Myotis sodalis) has been recorded in a single locality in Massachusetts (Chancy 1976). Although no individuals have been found in many years, it may still occur in the emery mines in Hampden County, Massachusetts. The mines have been given to the Massachusetts Division of Fisheries and Wildlife in an effort to protect remnants of the bat's population. It is unlikely that this species would be found on Deer Island.

Birds - The Bald Eagle (Haliaeetus leucocephalus) and peregrine falcon (Falco peregrins tundris and F. p. anatum) are all listed as endangered. The bald eagle is characteristically a bird of seacoasts, large remote lakes and river shores. Today, no known breeding populations are found in the state. However, a hacking program by state and federal wildlife agencies (28 eaglets in five years at the Quabbin Reservoir) has reintroduced the bird to Massachusetts (Dyer 1987). The program is scheduled to continue for another three years.

The 1987 winter bird survey found 42 eagles (possibly including a few golden eagles) in the Quabbin Reservoir area and 54 eagles state wide (Dyer 1987). So far none has nested in the area but sexual maturation takes five years and nesting may occur in the next few years. Although it is highly unlikely that bald eagles will ever nest in the harbor islands, even with an increase in their numbers, because of the levels of human activity (Dyer 1987), there is now the possibility of eagles visiting the area while migrating to other parts of New England.

Native breeding populations of the peregrine falcon have been completely extirpated throughout the eastern US, and the arctic peregrine now occurs in the region as a spring and fall migrant. However, the American peregrine falcon has also been successfully reintroduced along the east coast and in particular in Boston (Horwitz 1986). It is the only species listed by the Federal government as endangered which is likely to be found near Deer Island. A pair of peregrines, a three year old Boston male and a three year old Canadian female, have taken up residence on the McCormick Courthouse Building in Post Office Square and have successfully nested (French 1987a). This is the first successful nest in Massachusetts in 36 years (French 1987b). These birds hunt primarily in the Boston Harbor Islands and thus have a high likelihood of visiting Deer Island.
Of the vertebrates listed in Massachusetts as "threatened" (Ritzer and Franzen 1975), only one species, the Ipswich sparrow (Passercules princeps), could occur in the area of the harbor islands. The sparrow, classified as a subspecies of the Savannah Sparrow, breeds only on Sable Island off the southern coast of Nova Scotia. It winters along beaches, sand dunes and coastal marshes from Massachusetts to Georgia.

Sensitive Communities

The Massachusetts Natural Heritage Program (Michaud 1987) has no record of any rare plant or animal species or unusual plant communities on Deer Island. National Wetlands Inventory maps show no freshwater wetlands on Deer Island, other than the wastewater treatment plant reservoir at the top of the drumlin (USDI 1987). No wetlands qualifying under M.G.L. Chapter 131, S40 were found during the site visits.

Environmental Stress

Major environmental stress which can alter growth and development of biota includes plant diseases, insect pests, pesticides, fire, drought, winds, ice and snow, agriculture activities, air pollution, recreational activities and, occasionally, vandalism. Deer Island has served as a site for a variety of municipal facilities dating back to colonial times. It was the site of an internment camp for hostile Indians, a reformatory, and a quarantine hospital, and it has served as the outlet for the metropolitan area's sewage since the late 1860's. It also was the site of a cemetery and burial areas.

A majority of Deer Island has been subjected to extensive modifications and disturbance, particularly within the last 100 years. The most extensive have included the construction of concrete bunkers, radar and radio facilities and access roads. Related grading of slopes associated with Fort Dawes (1941) disturbed a substantial amount of the drumlin and land areas to the south. The subsequent construction and modifications of the Deer Island Treatment Plant (1968) added to this disturbance over the central part of the island. The prison and prior uses in the northern part of the site had previously disturbed the area to the north and northwest of the drumlin. The plant water reservoir at the top of the drumlin is operated by the MWRA.

Because of the extensive land modification caused by more than 100 years of periodic construction activity on Deer Island, very little area on the island has been untouched. As a result, there are no pristine or mature habitats on the island or on its shores and vegetation present on the island consists mainly of weedy invasion species.

Nut Island

Site Conditions

Nut Island is a small peninsula approximately 1,500 feet long and 500 feet wide (Figure 5.2.5-2). It consists of a substantially altered drumlin connected by a man-made causeway to a second drumlin on the mainland. The island is devoid of significant natural futures; any that existed when the island was in its original condition were eliminated when the site was employed for the wastewater treatment plant. The open space on the south end of the island is maintained as cut grass.

Flora

Weedy forbs and managed grasses are the only plant life found on the island. No wildlife habitat is present other than perching places for occasional birds.

There are no wetlands on the island (USDI 1987).

Fauna

Visiting gulls are the only evidence of wildlife found on Nut Island. Due to the high level of human activity on the island and the total lack of nesting and foraging areas, no other fauna of any significance are expected to use the island.

Endangered and Threatened Species

Because of the industrial nature of the site and the high level of human activity no endangered or threatened species of any kind are expected at the Nut Island site (USDI 1986).

## 5.3 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

Deer Island's historical and archeological resources date from the period from the 1840s to about 1930. They consist of a cemetery and mausoleum, the Deer Island House of Correction, and the Deer Island Pumping Station. Public Archeology Laboratory, Inc. (PAL) conducted the archeological surveys in 1985 to 1987, and Boston Affiliates, Inc. performed the survey of historical structures during the same period.

No historical or archaeological resources have been identified on Nut Island.

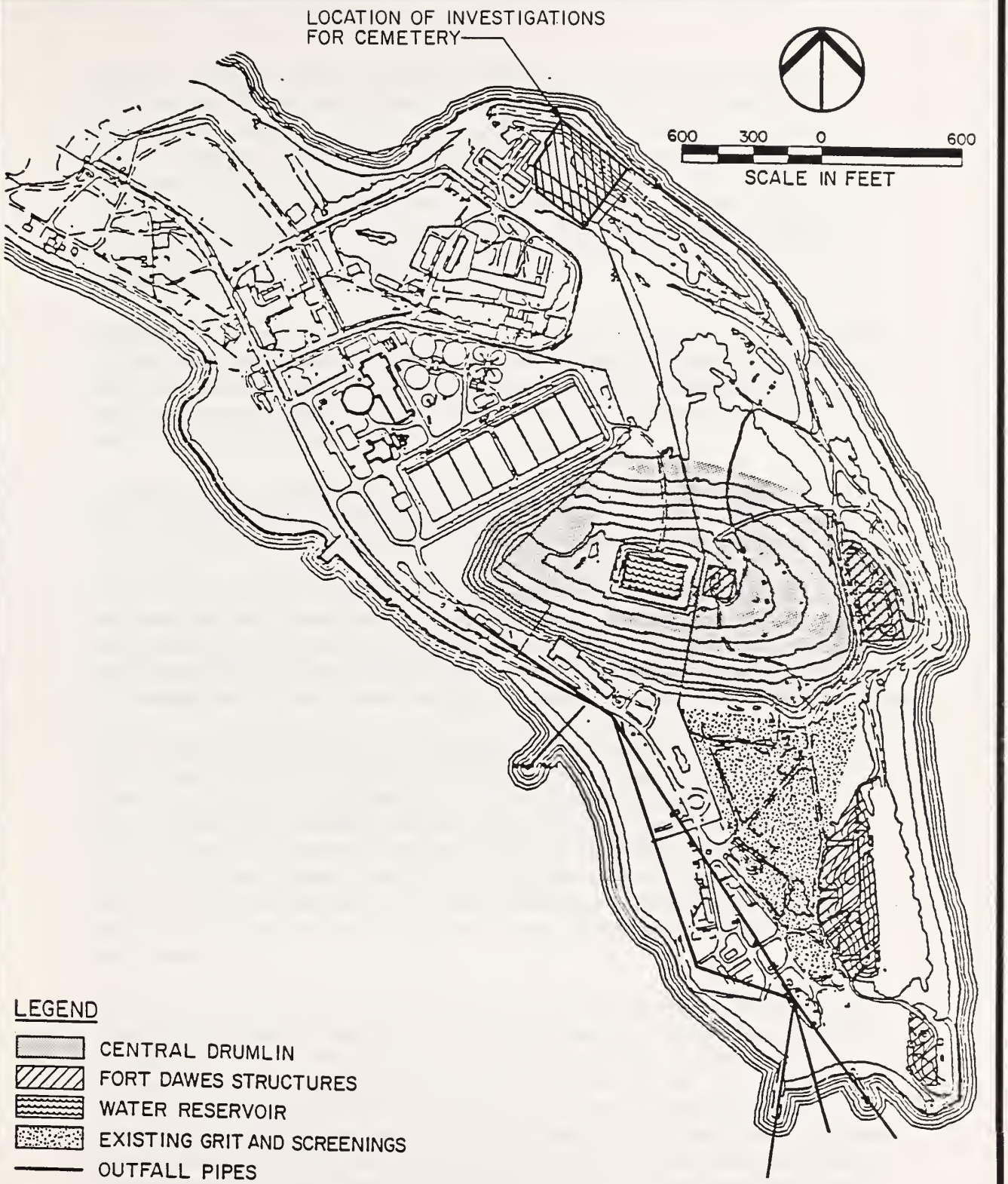
### 5.3.1 CEMETERY AND MAUSOLEUM

As part of the siting process for this project, a reconnaissance level archaeological survey was conducted by Public Archaeology Laboratory, Inc. (PAL) in September 1985 to identify and document cultural and archaeological resources as well as to assess the extent of previous disturbance within the designated project area.

In the course of the archaeological reconnaissance survey, an historic period cemetery and mausoleum were identified on Deer Island. (Figure 5.3.1-1). The cemetery plot and associated vault are located on a slope on the northeast side of the island between the old piggery and the concrete boundary wall that originally separated the City of Boston property from the U.S. military reservation on the southern half of Deer Island. It is referred to hereafter as the northeast, or new, cemetery.

A more intensive archaeological survey was carried out in 1987 by PAL to assess the significance of the historic period cemetery. The survey was carried out in two basic stages: documentary research, followed by site verification.

The specific objectives established for the documentary research were: (1) to establish the period of active use of the cemetery identified during the reconnaissance survey; (2) to establish if this cemetery is older than the 1908 mausoleum associated with it; (3) to




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 5.3.1-1**
**LOCATION OF CEMETERY INVESTIGATIONS**

determine, if possible, whether the cemetery contains any burials that were removed from earlier nineteenth century plots formerly located on other sections of Deer Island; (4) to determine if the cemetery plot near the 1908 mausoleum could contain older (nineteenth century ?) reinterred burials; (5) to consult records maintained by the military (Army Corps of Engineers) for any information relevant to the final disposal of burials from Resthaven Cemetery on the southern tip of Deer Island; (6) to determine when Resthaven Cemetery was first actively used by the correctional facilities; and finally, (7) to locate documentary sources describing the methods used in the burial of almshouse or prison inmates on Deer Island (individual graves, large trenches, etc.).

The documentary research indicated is that the new northeast cemetery plot, or New Resthaven, was much larger than expected from the cursory field inspection of the site. Judging by the 1929 photo included in Appendix O, the cemetery extended from the northeast wall of the old piggery to the cement boundary wall and from the sea wall at the top of the slope to the mausoleum at the foot of the slope.

The objectives for the fieldwork were: 1) to determine the horizontal extent of the cemetery through systematic subsurface testing; and 2) to collect sufficient data to reconstruct the internal configuration or plan of the cemetery and general mode of burial used at this site.

The site verification phase (fieldwork) of the study employed two procedures. First, geophysical data was collected through remote sensing using electrical resistivity and proton magnetometer surveys, to detect subserface disturbance in the soil and guide excavation for the location of unmarked burials. These results were used in conjunction with consultation with the Massachusetts Historical Commission (MHC), to plan an effective subsurface testing program.

Moisture content, granular size, density, and chemical content are factors which contribute to soil variations which are detectable by the resistivity survey. Using this method, the shaft feature from the excavation and refilling of a burial is detectable as higher resistance. Mineral content of soil, specifically the presence of mangetite or related minerals, will affect its magnetic susceptibility. Anomalies caused by the digging and refilling of holes will mix the mangetic domains of the soil and will register as areas of slightly lower magnetic intensity which can be measured by the proton magnetometer. Historic burials may also offer a different target anomaly if a coffin is used which contains metals having magnetic properties such as iron.

The results of the field, remote sensing study are described in Appendix O. Based on these results and the documentary research, a total of ten trenches were subsequently excavated using a combination of machine-assisted and hand excavation techniques. They were aligned judgementally to cover as much of the project area as possible with some trenches aligned to test the specific anomalies located by the remote sensing survey, and others were laid out to test the cemetery boundaries indicated on a 1920's photograph of the cemetery area. The area of testing for establishing boundaries extended beyond the boundary determined by documentary research to include marginal areas that might have been used as a burial ground before and after the date of that photograph.

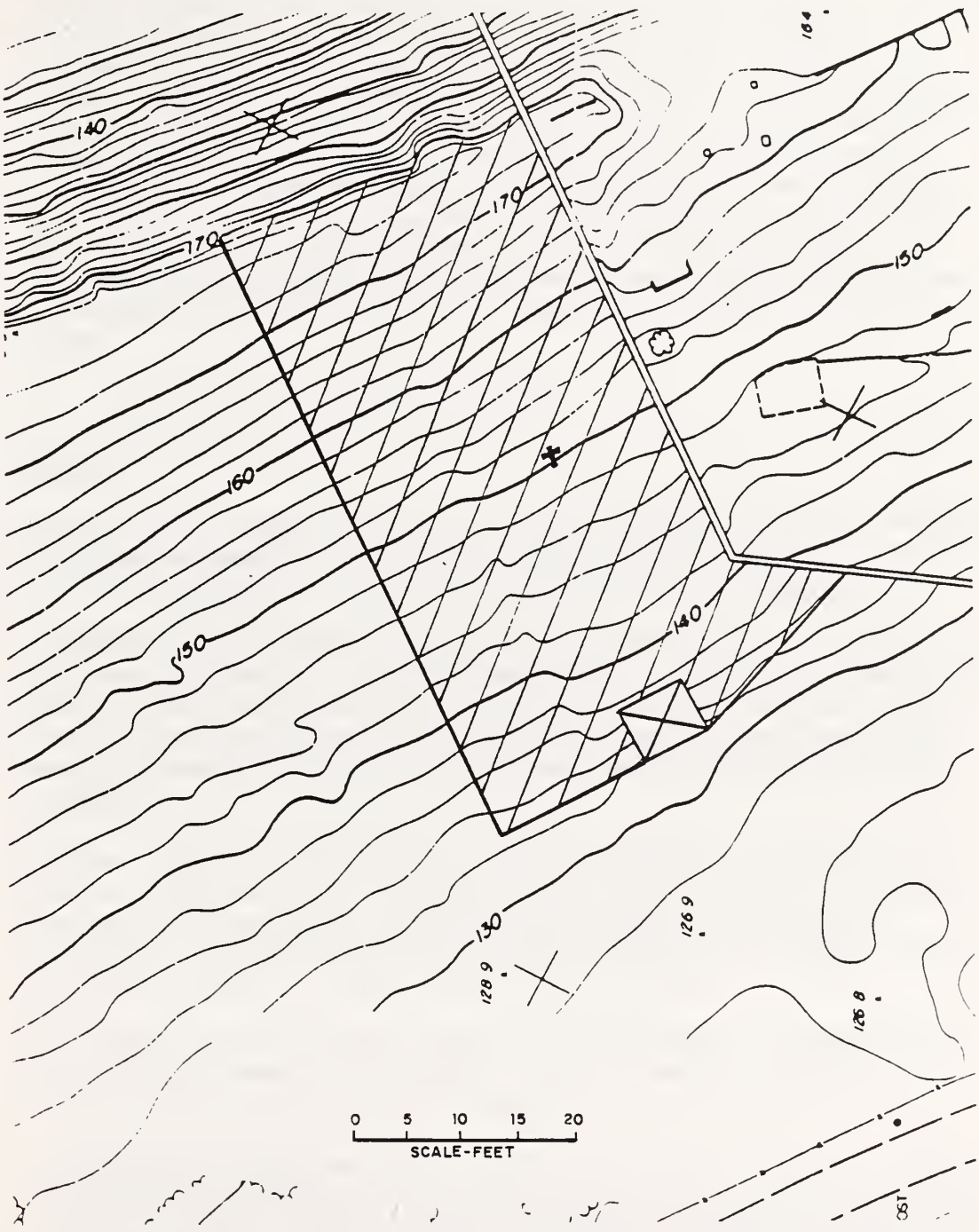
After consideration of all the evidence, it appears most likely that the cemetery in question is "New Resthaven Cemetery" created in 1908 with the reinterment of some 4,160 bodies from the old Resthaven Cemetery in the military reservation. The cemetery, at its present location, is 79 years old, or greater than 50 years in age. In addition, 2,559 of the bodies reinterred in New Resthaven are 100 years in age or older, many of them being quarantine hospital victims and Irish immigrants. An additional 92 unclaimed bodies were interred in the cemetery subsequent to its creation. The last recorded burials on the island occurred in 1946. As no evidence has been found suggesting the removal of these burials to another location, it is expected that some 4,252 bodies remain interred in the cemetery.

The documentary research initially suggested that the New Resthaven cemetery was potentially much larger than expected from the cursory field inspection of the site. Based on a 1920's photo, the cemetery appeared to extend from the northeast wall of the old piggery to the cement boundary wall mausoleum at the foot of the slope.

The 1939 and 1940s photographs included in Appendix O, show less extensive cemetery boundaries. This smaller cemetery plot is restricted to the portion of the slope above the mausoleum from the cement boundary wall northward approximately 30 to 40 meters to a picket fence. Archaeological fieldwork tended to confirm this smaller cemetery boundary. Only one trench, located within the confines of the smaller cemetery boundary, produced features related to the presence of an historic cemetery: wood and human bone were found in a very poor state of preservation. No grave shaft features were located in any of the other trenches. This data suggests that the cemetery did not extend more than a short distance beyond the northeast edge of the mausoleum. Figure 5.3.1-2 shows the probable revised boundaries of the cemetery based upon the documentary and subsurface testing data. The northwest boundary is an approximation primarily based upon the photographic evidence.

Evidence for the internal configuration and mode of the cemetery was provided by the historic photographs and the locations of features in the one trench where remains were observed. The presence of a gridded pattern of wooden crosses in the historic photographs suggests individual graves packed close together. It is also possible that the crosses marked bodies buried in trenches or in a mass burial.

An attempt to count the number of crosses in the photographs led to another possibility. There were approximately 79 crosses in the area above the mausoleum between the concrete wall and picket fence visible in the 1929 photograph (Appendix O). This correlates closely with the total of 92 bodies buried on Deer Island after 1908. It is possible, therefore, that the burials and crosses correspond to these 92 "new" interments (between 1908 and 1946). This leaves the loation of the reinterments unclear. Considering the very poor preservation of the wood and bone which was found and the large otherwise unexplained geophysical nomaly in part of the area which was tested, it is possible that the reinterred bodies were buried in a mass grave in this location in 1908. Subsequent burial of the more recent bodies and the intervening 79 years may have erased most evidence of these 4,160 reinterred bodies.




MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 5.3.1-2**
**REVISED BOUNDARIES OF NEW REST HAVEN CEMETERY, DEER ISLAND**

A number of factors may have combined to cause the poor preservation exhibited by the burial that was found and the general lack of visible burials. First is the age of the burials, especially the reinterments. The majority of the burials predate 1850. Second, there is no evidence to suggest that any of the bodies were embalmed before burial. Indeed the 1934 memo indicates that this was not done in the more recent period. Third, it is highly unlikely that the earliest, and therefore the majority, of the burials were interred in coffins. This could tend to detract from preservation potential. Fourth, no information was located concerning the methods used to exhume and then reinter burials in 1908: it is unlikely that great care was taken in their transfer. Finally, the cemetery's location on the bluff near the Atlantic ensures the frequent drenching of the plot by salt water and spray during storms and high seas. The corrosive nature of salt water may have contributed to the poor preservation of the burials.

### 5.3.2 DEER ISLAND HOUSE OF CORRECTION

History

Owned by the City of Boston since 1634, Deer Island in Boston Harbor has proven a useful place for purposes that needed a site, but that had to be set apart from a populated area. Its use has included the detention of Indians and the quarantine of contagious immigrants.

In 1850 the City sited a municipal almshouse there, which became the first in a complex of institutions serving the poor, the criminal and the delinquent. The almshouse was known as the House of Industry; other buildings, such as a reformatory, and schools for pauper boys and girls, were added in the next three decades. In the 1890's the whole complex started being used for the detention of prisoners, and was called the House of Correction, the name still used today.

The Deer Island group of institutions for many years was self-sufficient, providing its own food from animals and farming. Dairy barns were built as late as the 1950's but farming has now ceased. The Island was accessible by boat, and the Penal Institutions Department maintained its own steamboat to transport inmates between islands and the mainland. In 1940 the Island was connected by causeway to Point Shirley in Winthrop.

Deer Island has not previously been surveyed for historical significance. Consequently, none of the buildings are listed in official inventories or have been identified as eligible. The main points of historic interest are the following:

1. Administration Building (ca. 1850, 1929, 1949)
This building incorporates major sections of the Deer Island Almshouse (also known as the House of Industry), designed by Gridley J. F. Bryant (1816-1899) with the assistance of Louis Dwight of the Prison Discipline Society. The original building was of brick, in Italianate and vernacular style.

Fire damage in 1929 and 1949 led to the removal of the roof and portions of the building.

Modern sections were added at the back.

Interior hallways and offices on the first floor have woodwork, matchboard panelling, and cast-iron columns which are apparently original. The cell-block appears to date from the late nineteenth century, and is probably the addition designed by City Architect Edmund Wheelwright in 1892.

The building is now used as administrative offices, reception and cells for new prisoners, training and schoolrooms, and workshops. The building appears structurally sound but worn and neglected.

2. Hill Prison (1902-04)
This building appears to be substantially unaltered. It was built as a women's prison, but is now the main prison in the complex, occupied solely by men.

The architect was A. Warren Gould, active in the 1890's in Boston, where he designed a number of houses and buildings in Dorchester, including Whiton Hall for the Dorchester Women's Club. He moved to the Pacific Northwest and died in Seattle in 1922.

The building is T- Shaped. The two wings contain cell-blocks, the rear wing dining and recreational facilities. The building is of loadbearing brick, 24 in. thick at first floor level; the foundations and entrance facade are granite. The floor construction is reinforced concrete, and brick vaults span the cell-block open areas. Interior supports are cast-iron columns and masonry. The pitched roofs are covered with slate.

The style of the building is classical revival. The central section has a granite facade in the lower half, brick in the upper half. In the granite section, two projecting bays flank an arched entrance in Palladian style, above which is a recessed balcony set in a semicircular arch. Above are a series of vertical brick pilasters between windows, topped by an entablature and surmounted by a hipped roof with clipped dormers and a prominent cupola.

The two wings contain a series of wide brick pilasters alternating with narrower barred windows arched at their tops. Since these windows give onto the open space of the cell-blocks, there are no floors behind them, and the windows are virtually continous strips. Above is a broad entablature. The roof is pitched, and has ventilators at the ridge, which were once open roof viewing platforms. The end walls of the wings have the same pilaster and arched window motif of the front and rear elevations; the windows are bricked up.

The rear wing, also roofed with a pitched slate roof, has a series of brick semicircular arches, with windows at each floor level. In the uppermost floor -- the recreation hall -- the upper section of the window is blocked with plywood. The end wall of this wing is the stage wall, and is solid brickwork. The outer skin of this wall collapsed recently, and has been replaced.

Inside the building, most of the spaces are utilitarian. There is some architectural interest in the front entrance hall and in the recreation hall, which still retains original woodwork in

the doorways, stage and proscenium arch, and balcony.

The building appears to be structurally sound. Inside, all surfaces show signs of much wear, poor maintenance, makeshift repairs and careless painting.

3. Superintendent's Office (1930)
This red brick building, situated on the waterfront opposite the Administration Building, originially housed doctors and other professional staff of the Deer Island HOC.

The building, which resembles a traditional single-family home, is Georgian Revival in style. It is composed of a rectangular 2-1/2 storey block with a high-pitched slate roof and a flat-roofed single storey service wing to the side. It is faced with Flemish Bond red brick and has a cast stone foundation and details.

The main facade has three bays of windows on either side of a central entranceway consisting of a pair of Corinthian columns and a segmental arch. The front slope of the roof has five gabled dormers; the rear of the structure has four dormers and four pairs of french doors leading onto a cast-stone terrace.

The Superintendent's Office was initially believed to date from circa 1910, based on visual analysis. Subsequent research, however, has indicated that it was constructed in 1930 to replace the original doctor's wing destroyed in the fire in the Administration Building in 1929. The structure was designed by the M.A. Dyer Company, a Boston architecture and engineering firm.

Subsequent to its use as the doctors' house, the structure became the Penal Commissioner's residence. Beginning in 1973, it housed inmates participating in the Work-Release program. In 1985, the building was renovated for use as office space. This renovation resulted in considerable alteration to the interior and the replacement of the original windows with vinyl copies.

4. Ancillary Buildings
   a. Garage - 20th century.
   b. Commissary - 20th century. This building, previously three and a half stories, was reduced to a one-storey building in 1946.
   c. Dormitories (former Dairy Barns) - 1957 and 1958. Architect, Joseph F. Page.
   d. Shower Block - probably the former Poultry House, 1957. Architect, Joseph F. Page.
   e. Chapel - 1950's.
   f. Power Plant - 1958. Engineers, J. M. McKusker Associates.
   g. Dormitory and Laundry (opposite Hill Prison) - this building may be a remnant of the nineteenth century pauper girl's school.
   h. K-9 Quarters - 1980's. On site of former piggery.
   i. Work Release House - 1920's (?)
   j. Sheet Metal Shop - 20th century.

5. Site Plan (ca. 1850 to present)

The Deer Island House of Correction consists of a grouping of major and ancillary buildings informally sited in an institutional yet rural setting.

The buildings form two clusters. Near the water's edge, the predominant building is the Administration Building, sited parallel to the main road that traverses the island. Opposite the Administration Building is the Superintendant's Office; nearby is the Work Release House. Behind the Administration Building and parallel to it are a Garage and Commissary.

Up on the hill the predominant structure is the Hill Prison, sited on a street sometimes referred to as Hill Prison Street. Across from the Hill Prison is the Dormitory and Laundry. Next to the Hill Prison are two Dormitories, a Chapel, and Shower Room, and the Power House. Below and across a road is the Sheet Metal Shop. Behind the Hill Prison are the K-9 Quarters.

The buildings are informally set on the site which has a character that is institutional, industrial and rural. There is a loop road that gives vehicular access to all buildings. It is paved, but without curbs in most places. The largest expanse of paved area is between the Administration Building and the Garage and Commissary. Stone retaining walls and foundation walls of demolished buildings occur on the site. Cyclone fencing and wooden telephone poles are in evidence. Trees, bushes and an overgrowth of grass contribute to the rural character of the site.

Significance

The Massachusetts Historical Commission reviewed the historical and architectural survey in December 1987 and made the following finding about the Deer Island House of Correction's historical significance (see Appendix O):

We . . . found that the Deer Island prison complex does not meet National Register of Historic Places Criteria, but that several components individually meet NR criteria.

While individual components of the Prison Complex do retain integrity to their period of significance, the complex as a whole does not, having been altered through the construction of numerous small utility buildings in the 1940s, 1950s, and 1960s and through the demolition or substantial alteration of original elements and significant later structures, such as the ca. 1850 House of Industry and the Pauper Boys' School.

Components considered to retain integrity to their period of significance and to meet National Register criteria A and C on the local level are the following:

Hill Prison (1902-04) - Classical Revival building retaining significant elements of its design; significant for its associations with the development of institutional controls in

the city of Boston; as an illustration of the continued usage of the Harbor Islands as the historic location of undesirable social institutions (Boston's institutional fringe) and architecturally as a good example of turn-of-the-century institutional design and practice, reflecting current philosophies regarding criminal justice and social reform.

The Superintendent's Office (ca. 1910) is an excellent example of Georgian Revival architecture in a good state of preservation. Historically, the office reflects the importance and high status of the Superintendent in its prominent siting and imposing design. (Further research has shown that this building was built as the Doctor's House in 1930.)

### 5.3.3 DEER ISLAND PUMPING STATION

History

In 1889, legislation, prompted by reports of the Massachusetts State Board of Health on pollution of Boston Harbor, authorized the formation of the Boston Metropolitan Sewerage Commission. By 1900, the North Metropolitan Sewerage System, serving the 14 cities and towns of the Commission's northern region, was fully operational.

The North Metropolitan system's 74 miles of sewer lines connected nearly 1,000 miles of local lines and pumped to an outlet in the Boston Harbor at Deer Island. The Pumping Station at Deer Island was the largest of three stations constructed to pump sewage through the North Metropolitan system. Constructed in phases in the period from 1894 to 1900, the Deer Island Pumping Station's development reflected the growing needs of the region's burgeoning population.

The Pumping Station at Deer Island lies on the southwesterly side of the island about midway down its length. Actually a complex of five attached buildings, the development of the station reflects the development of the North Metropolitan Sewerage System which it served. Completed in three phases between 1894 and 1899, the complex contains a Screen House, Coal House, Boiler Room and two Engine Rooms. The buildings give the appearance of a single structure, designed in a compatible manner by Arthur F. Gray, architect for the stations at Charlestown and East Boston. Though operated in the periods between construction, it became fully operational in May of 1900. The Station was in operation until 1968 when the Deer Island Sewage Treatment Plant was completed. The building, still containing the old machinery, is now abandoned. To the southeast of the pumping station complex is a two-storey shingle structure referred to as the Farmhouse.

Looking east along the westerly elevation of the drumlin, the Pumping Station buildings are, from left to right:

1. Screen House (ca. 1895)
A two-storey brick, granite and terra cotta structure 27 ft x 23 ft. Built in a simple vernacular industrial style with Queen Anne - Romanesque elaborations and detailing, it has a

hipped roof of slate with terra cotta tile coping and is surmounted by a cupola, now only partially extant.

The building covers the screen shaft of the pumping station system and contains machinery for hoisting and pressing. Sewage was screened with double rows of wrought iron bar cage screens before it was put through the pumping machinery. The Screen House and the adjacent Coal Pocket were constructed after the Boiler Room and the first Engine Room.

2. Coal Pocket (ca. 1895)
A one-storey brick, granite and terra cotta building, 74 ft x 34 ft with a dynamo room attached. Styled similarly to the Screen House, it also has a slate pitched roof punctuated by dormer-type openings and terra cotta tile coping.

The engines for the pumping station were powered by coal burned in the boiler room until the facility was converted to diesel fuel in the 1950's. The Coal Pocket was designed to hold 600 tons of coal.

3. Boiler Room and Chimney (Sept. 1894)
A one-storey brick, granite and terra cotta structure, 63 ft x 35 ft with a height of 17 ft to the roof trusses and an accompanying masonry chimney 125 ft in height. The structure is styled in a vernacular Romanesque with Queen Anne details, slated pitched roof with terra cotta tile coping and topped with a ventilation structure. Converted from coal to diesel in the 1950s, the boilers still remain intact. The boiler room and the first engine room were the initial structures built for the pumping station, which shares its pattern of boiler room-engine room with the stations at East Boston and Charlestown.

4. Engine Room (first) (Sept. 1894)
A one-storey brick, granite and terra cotta structure, 100 ft x 31 1/2 ft, with a height of 15 ft to the roof trusses. Styled in a vernacular Romanesque with Queen Anne detailing, it also has a pitched slate roof punctuated by dormer-type openings and with terra cotta tile coping. Similar to the stations at East Boston and Charlestown, it was originally equipped with two triple-expansion Corliss type steam engines.

5. Engine Room (second) (ca. 1899)
A two-storey brick structure approximately 50 ft by 50 ft with a hipped slate roof. The structure is built in a more formal style with Romanesque details of round-headed arches, brick patterns to create circles, and horizontal lines denoting function.

Because of a need for increased system capacity, an extra pump and engine were added to the Deer Island Pumping Station and housed in this structure. The machinery is still extant.

6. Farmhouse (ca. 1900)
Approximately 300 feet to the southeast of the Pumping Station stands a two-storey wood and shingle Queen Anne/Colonial Revival structure that is known as the Farmhouse. Physical evidence indicates that the original structure, a simple rectangular two-storey barn, received later additions, probably around the turn of the century. The original barn forms the north

wing, while the later construction consists of the central stable-like area and the attached south wing. The south wing apparently was designed and used as a residence for employees of the Pumping Station, and possibly the Superintendent. Employees of the Pumping Station at various times used the north and central wings as a locker building, tool room, stable, and garage. The M.D.C. at one time used the Farmhouse as a storage area for old documents, tires, and sand. It is now in dilapidated condition.

Significance

The Massachusetts Historical Commission, in its review of the historical and architectural survey of Deer Island, concluded the following about the Pumping Station (see Appendix E):

> . . . we find that the Deer Island Pump Station Complex appears to meet National Register Criteria A and C.
>
> The Pumping Station meets criteria A and C,
> 1) as a substantially intact sewage pumping complex illustrating the development of the Metropolitan District Commission, one of the earliest major environmental management agencies in the country, and of the City of Boston and its surrounding area, which experienced substantial growth at the turn of the century and
> 2) as an architecturally distinguished pair of buildings in the Romanesque Revival and Queen Anne styles. The pumping station, built between 1849-99, is notable for its high quality design and materials while the adjoining farmhouse is a particularly good example of Queen Anne/Shingle Style architecture.

# Section 6

# 6.0 WASTEWATER FLOWS AND LOADS

## 6.1 AIR AND WASTEWATER SAMPLING PROGRAM

During the Fall of 1986 and the Spring of 1987 Camp Dresser & McKee (CDM) conducted a wastewater, sludge, and air emissions sampling program.

The wastewater sampling was conducted during both the Fall and the Spring periods. The air sampling was only conducted during the Fall period. The sludge sampling was only conducted during the Spring period.

### 6.1.1 OBJECTIVES AND GOALS

The objective of the wastewater, sludge and air emissions sampling program was to collect statistically valid data that would quantify the unique character of the MWRA's existing influent wastewater, primary sludge, and air emissions.

The wastewater, sludge and air emission samples collected from the various facilities is an integral part of both the Secondary Treatment Facility Plan (STFP) and the Residuals Management Facility Plan (RMFP). The wastewater, sludge and air emission samples are important because the data obtained is the basis for several other elements of the studies that define the proposed treatment facilities.

The three primary goals of the sampling program were to:

1. Provide data for the STFP to evaluate wastewater treatment plant processes, and outfall selection.

2. Provide data for the RMFP to evaluate probable sludge characteristics for residual treatment and disposal alternatives.

3. Provide data for the evaluation of air quality impact that would result from volatile organic compound (VOC) emissions and the odor potential associated with alternative wastewater treatment facilities.

To achieve these goals CDM and its sub-contractors followed a detailed quality control and assuance document (QA/QC) enclosed in Appendix B. That QA/QC conformed to EPA standards as defined in its 1984 publication entitled, "Guidance for the Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring."

The individual samples' analytical results are detailed in Appendix B in four volumes entitled "Summary Memorandum FB20c Air and Wastewater Sampling Program". Volumes I thru III are the results of the fall program. Volume I contains conventional process metals, ABN's and PCB pesticides data. Volume II contains the results of wastewater volatile organic sampling. Volume III contains the result of air volatile sampling. All the spring results are contained in Volume IV.

### 6.1.2 THE SCOPE OF THE SAMPLING PROGRAM

Sampling Locations

The two MWRA sewer service areas are called the South Metropolitan System and the North Metropolitan System, reflecting their relative locations. The South System reaches its terminus at Nut Island. The North System after preliminary treatment at four headworks (Chelsea Creek, Columbus Park, Ward Street and Wintrop Terminal) reached its terminus at Deer Island. In order to gather data it was necessary to collect samples from six influent wastewater locations, five effluent wastewater locations, two sludge pumping locations and three air emmission vent locations.

Within the South System influent and effluent sampling locations were set up at Nut Island. However, the North System required more locations due to its more intricate design. In the North System influent and effluent sampling locations were set up at Deer Island, Chelsea Creek, Columbus Park, and Ward Street. An influent sample location was also set up at Wintrop Terminal. At all sites, the influent sampling location was placed at a point before screening facilities. At Chelsea Creek, Columbus Park, and Ward Street the effluent sampling locations were placed after the headworks grit and screening facilities. During the fall period, at Nut Island and Deer Island the effluent sampling locations at were located after primary treatment, and before the chlorination processes. During the Spring period, there were two effluent sampling locations at Nut Island and Deer Island. One before the chlorination process and the other after the chlorination process.

During the spring sludge sampling locations were set up at Nut Island and at Deer Island at the sludge pumps. Each site has multiple sludge pumps, each with a sampling valve. The samples were taken from the various pumps at each site on a rotating basis.

For the air emmissions, sampling locations were set up at Chelsea Creek, Columbus Park, and Ward Street. At each site the sampling location was set at the top of the tunnel shaft, where the wastewater dropped several feet to the tunnel (either the North Metropolitan Relief Tunnel or Boston Main Drainage Tunnel that leads to Deer Island.

Constituents Sampled

When establishing the list of constituents to analyze the list was based upon process consideration as well as EPA and state guidelines. In total, more than 150 constituents were specified prior to sampling. These include all constituents from the:

Conventional Parameter List
Priority Pollutant List
Harzardous Substance List (Organics Only)
Massachusetts Sludge Metals List
Massachusetts Ozone Precision Guidelines

In addition to the organic compounds that were specifically searched for, the presence of other organic compounds were identified by the use of comparation (library) searches of the mass spectrographs.

The specified constituents to be analyzed were categorized by analytical fractions. Samples were taken for each fraction based on a schedule and technique designed to ensure data quality for each fraction.

The fractions created for this sampling program with the type of sample that was taken in paranthesis were:

1) Conventional and Process Parameters (Wastewater)
2) Metals (Wastewater and Sludge)
3) Acid and Base/Neutral (Wastewater)
4) Pesticides and PCBs (Wastewater and Sludge)
5) Volatile Organic Compounds (Wastewater)
6) Total Non-Methane Organic Compounds (Air)
7) Volatile Organic Compounds (Air).

### 6.1.3 DATA QUALITY ASSURANCE

The usefulness of the of the sampling program results depended upon the adherence to the data quality requirements that were incorporated in the quality assurance and control specifications. Data quality is based on precision, accuracy, representativeness, completeness and comparability. There are several ways that the program design and the laboratory procedures quaranteed data quality. These are discussed below.

Duplicate Samples.

Samples taken at the same location in the same manner and at the same time are considered duplicates. Duplicate samples should have nearly identical composition and minimal variation. By analysing duplicate samples, the laboratories demonstrate precision and comparability in their analytical method.

At each sampling location approximately 5% of the samples were duplicats. The results from the analysis of duplicate samples has indicated that laboratory precision and comparability was within acceptable limits unless noted otherwise in the reported data.

Blank Samples and, Matrix / Surrogate Spikes.

Distilled water is considered a blank sample. Blank samples permit the testing of the equipment to ensure its intrinsic neutrality during the testing process. Placing known quantitites of certain constituents in distilled water will create matrix and surrogate spikes. By analyzing the spiked sample it is possible to determine if the testing equipment is capable of detecting the constituents that are being searched for. By analysing blank and spiked

samples the laboratories demonstrate accuracy in their analytical method.

Blank and spiked samples were analyzed throughout the testing of air and wastewater samples. Some minimal problems with the accuracy of the equipment was occasionally detected and are so noted in the reported data. Problems resulting from the large number of constituents that were being searched for during the tests occured (most notably with Boron during the Fall sampling). The problems did not compromise overall data quality and were corrected when possible corrected.

Multiple Samples

The collection of multiple samples per day, and the collection of samples over multiple days during different seasons constitutes multiple samples. By handling the multiple samples in a consistent manner the laboratories ensure the representativeness of the samples taken. The sampling program was designed to collect multiple samples on multiple days during different seasons. These multiple samples were handled in a consistent manner ensuring data quality.

Statistically Significant Number of Samples.

The program was structured to collecting enough samples so that the confidence interval about the mean of the analytical results was small enough to be considered statistically significant. In general, for compounds with little variability in analytical results, twenty (20) samples is enough to be statistically significant. For other compounds, such as VOC's, a larger sample field is necessary.

The sample program specified hundreds of samples. These samples were collected and analyzed a high percentage of the time. As a result, enough samples were collected to meet the statistically significant data standards.

Comparability of Sampling Method and Analytical Procedures.

Adhering to EPA Guidlines and industry standards constitutes approved sampling and analytical procedures. By using an approved sampling method and analytical procedures it is possible to ensure comparability of the results of individual samples with others in this sampling program, and with other sampling programs.

The sampling program adhered to the "Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983" ensuring that the program met EPA standards. The sampling program also adhered to the "Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985" ensuring that the program met industry standards. By meeting EPA and industry standards the sampling program satisfied the comparibility criteria of data quality.

### 6.1.4 THE EXECUTION OF THE SAMPLING PROGRAM

The sampling program was conducted under the direction of CDM with the assistance of Alliance

Technologies Corporation for sample collection. Analysis was conducted by CDM's labs, Alliance Technologies Labs Research Triangle Laboratoric Labs and Mead Compuchem Laboratories.

Coordination for Concurrent Collocated Sampling

The average travel times from Chelsea Creek, Columbus Park, Ward Street and Winthrop Terminal to the Deer Island Plant were taken into account in the establishment of sampling times. As a result, the sampling was staggered such that any given sample of wastewater would have arrived at Deer Island at approximately the same time. By staggering the sampling times it was possible to collect concurrent collocated samples.

The anticipated travel time from the Nut Island plant across the harbor to the Deer Island Plant was not taken into account.

Wastewater Sampling Technique

During the program influent samples were flow composited by collected by in automatic sampling equipment. In the case of the plant effluent and the volatile organic compounds, grab samples were taken. All wastewater samples are identified by sampling location, sampleing date, and time.

Sludge Sampling Technique

Grab samples of raw primary sludge from the Deer and Nut Island plants was taken for five (5) days. At Deer Island the sludge samples were collected every 4 hours from sampling taps located in the pump rooms in the basement of the Sludge Thickener Building. At Nut Island the sludge samples were collected every 4 hours from the various primary sludge pumps.

Air Sampling Technique

Air sampling for individual volatile species, as well as for total volatile concentrations, was done at Chelsea Creek, Columbus Park, and Ward Street during the Fall period of the sampling program. At each site there is a verticle shaft where wastewater drops to a tunnel that leads to Deer Island. All air samples were taken from the top of these shafts which acts as a vent.

The shafts were selected for air sampling because as wastewater drops into the tunnels, volatile organics would be stripped from the wastewater by the turbulence. The rate of organic volatalization at treatment facilities is a new area of concern and the sampling program represented an attempt at delineation between the concentration of volatiles in the wastewater and the rate of volatilization into the atmosphere.

Variables During the Sampling

Pollutants are likely to vary under different conditions. The following variations in the conditions that affect the treatment process were considered.

The sampling program was split between a Fall period and a Spring period. This split allowed ground water conditions to be taken into account. Groundwater levels vary with the seasons. In the Fall groundwater is low and in the Spring groundwater is high. The average flow during the Fall was 227 MGD at Deer Island and 93 MGD at Nut Island. The average flow during the Spring was 312 MGD at Deer Island and 174 MGD at Nut Island.

By taking samples under high and low groundwater conditions, it was possible to evaluate the impact of groundwater flow on constituent concentrations.

Most of the samples taken during the sampling program were flow composited daily samples. As a result these samples reflect the diurnal wastewater conditions experienced throughout the day.

In the case of volatile organic compounds that required grab samples, diurnal variation was taken into account by taking four grab (4) samples per day at six hour intervals. For the parameters, COD and TSS analysis were run on hourly samples collected from the two plants on two separate occasions.

Limitations of Laboratory Analytical Equipment

Even under the best conditions analytical laboratory equipment has limited precision and accuracy. Limitations include the smallest concentration of each constituent that can be identified (detection limit) and the accuracy of the reported value of the concentration.

The smallest concentration of a constituent that can be reported is called its detection limit. In general the detection limits used for laboratory analysis during this sampling program complied with industry standards. However, in the case of both metals and volatile organic compounds, the detection limits were made as low as feasible. The detection limit was lowered to provide usable data that would correspond to regulatory criteria for the allowable discharge level of the compounds.

While the detection limits were generally found to be acceptable in the Fall period of the sampling program, there was a problem with the detection limits of metals. Most of the samples tested in the Fall indicated that metals were below detection limits (BDL). As a result there was some uncertainty about the presence of the metals which were BDL. As a result the detection limits were further reduced during the Spring period of the sampling program. By reducing the detection limits to the lowest possible limits the metals data quality was raised to the highest possible level.

The calibration of laboratory equipment at low detection levels is delicate and is subject to error. While the QA/QC for laboratory procedures kept this error to a minimum the reported values are not exact. According to the laboratorys' documentation and quality assuance reports, the concentrations reported could be 15% more or less than the actual concentration. Note that this is commonplace within the industry and is of acceptable quality.

This variability is mentioned to allert interested parties to the intrinsic variability in analytical laboratory reports.

Laboratories Used to Test Samples

The wastewater samples taken during the Fall period of the sampling program were analyzed either by CDM's laboratory (process, conventional and VOC's) or by Mead/Compuchem Laboratories Incorporated (PCB's Acid Base/Neutrals, VOC's). All of the wastewater samples for metals were analyzed by CDM's laboratory.

The air emission samples taken during the Fall period of the sampling program were analyzed by either Alliance Technologies Corporation (total VOC's) or Research Triangle Laboratories, Inc. Compound Specific VOC's).

All PCB, Acid Base/Neutral, VOC and Pesticide wastewater samples taken during the Spring period of the sampling program were analyzed by Mead/Compuchem Laboratories Incorporated. Mead/Compuchem was used to analyze all Spring samples because its laboratory was able to detect constituents at lower concentrations than CDM's laboratory was able to achieve. CDM's laboratory analyzed all of the metals, conventional and process samples during the Spring period.

CDM's laboratory performed metal analysis on all sludge samples taken during the Spring program. Mead/Compuchem analyized sludge samples for PCB's and pesticides.

No air samples were taken during the Spring period of the sampling program.

### 6.1.5 SUMMARY OF SAMPLE COLLECTIONS

The sampling program was divided into two periods to allow the seasonal effects of groundwater levels to be evaluated. The first period, known as the Fall period, took place from August 29, 1986 to September 26, 1986. The second period, known as the Spring period, took place from February 29, 1987 to April 9, 1987.

Table 6.1.5-1 summarizes the number of samples collected by constituent category and by type of sample.

The Quality Assurance Plan (Q/A Q/C) is included in Appendix B of this report. The complete sampling results are contained within a four volume set. Copies of the results are on file at the MWRA and are available for inspection.

## TABLE 6.1.5-1

## TYPE AND NUMBER OF SAMPLES COLLECTED DURING FALL AND SPRING SAMPLING PERIODS

| Constituent Category | Wastewater Influent | Wastewater Effluent | Wastewater Sludge | Air | Total Samples |
|---|---|---|---|---|---|
| Fall Sampling Period | | | | | |
| 1) Conventional and Process | 162 | 4 | --- | --- | 170 |
| 2) Metals | 40 | 4 | --- | --- | 44 |
| 3) Acid and Base Neutrals | 21 | 4 | --- | --- | 25 |
| 4) Pesticides and PCBs | 17 | 3 | --- | --- | 20 |
| 5) Volatile Organic Compounds | 109 | 107 | --- | --- | 216 |
| 6) Total Non-Methane Organic | --- | --- | --- | 65 | 65 |
| 7) Volatile Organic | --- | --- | --- | 69 | 69 |
| Total of All Categories | | | | | 609 |
| Spring Sampling Period | | | | | |
| 1) Conventional and Process | 73 | --- | --- | --- | 73 |
| 2) Metals | 12 | 8 | 5 | --- | 25 |
| 3) Acid and Base Neutrals | 6 | --- | --- | --- | 6 |
| 4) Pesticides and PCBs | 12 | 6 | 6 | --- | 24 |
| 5) Volatile Organic Compounds | 17 | 17 | --- | --- | 34 |
| 6) Total Non-Methane Organics | --- | --- | --- | --- | |
| 7) Volatile Organics | --- | --- | --- | --- | |
| Total of All Categories | | | | | 162 |

## 6.2 FLOWS AND LOADS

### 6.2.1 INTRODUCTION

This section sets forth the results of investigations concerning projected wastewater flows and loadings for the new Deer Island Secondary Treatment Plant. The wastewater and associated pollutants received at the MWRA's treatment facilities originate from a variety of sources: domestic wastewater associated with residential activities; nondomestic wastewater associated with the commercial, industrial, institutional, and other business activities of the region; infiltration and inflow; and stormwater flow. Infiltration and inflow is water other than domestic and nondomestic wastewaters that enters sewers unintentionally, and results from the age, condition and location of the more than 5,000 miles of public sewer pipe tributary to the MWRA's treatment facility. Stormwater flow is the flow that results from the combined systems which carry both wastewater and street drainage and is intentionally allowed into the sewer system.

In preparing estimates of flows and loads, two broad assumptions have been made concerning the Authority's future wastewater treatment strategies.

- The service area will be limited to the communities now named in the Authority's enabling legislation. Only a few small communities at the edge of the Authority's service area are not now served by wastewater collection and treatment facilities and could be considered potential additions to the MWRA's service area. These are residential communities which, if added to current estimates, would represent an increase of only about one percent of the total service area population.

- The new Deer Island Secondary Plant will play a significant role in the Authority's future programs to manage combined sewer overflows (CSO). The existing Deer Island Main Pumping Station, together with the existing conveyance system, has the capacity to deliver large volumes of combined wastewater and stormwater runoff to Deer Island. Wastewater planning for the secondary treatment plant has been conducted under the assumption that the facility at Deer Island would continue to receive a substantial portion of the annual combined flow volume. A 1982 CSO Facilities Plan recommended decentralized storage and additional treatment facilities located throughout the combined sewer service area to treat excess combined flows. As well, a preliminary feasibility analysis of deep tunnel storage for combined sewer overflow control was conducted for the MWRA in 1986. Although the approach to CSO control would be different if the Authority were to adopt a deep tunnel plan it would not have a significantly different impact on the design of the Deer Island Secondary Treatment Facilities. Both methods would store and return CSO, resulting in extended operation at higher than average flow rates.

This section also sets forth the characterization of nonconventional pollutants. The non-conventional pollutants categories are: metals; acids; bases and neutrals; pesticides and PCBs; and volatile organic compounds.

## 6.3 FLOW ESTIMATES

### 6.3.1 GENERAL

The volume of wastewater produced in the Authority's service area is directly related to the following factors:

- the sewered population of the service area and the volume of water used by the residents and returned to the sewer system as domestic wastewater.

- the economic activity taking place within the service area which drives area growth and employment and thus the volume of nondomestic wastewater discharged as a result of commercial, industrial, manufacturing and employee usage.

- the rainfall in the service area, which enters the sewer system as infiltration/inflow or as direct stormwater flow, and the groundwater levels in the service area which, when high, add to the volume of infiltration/inflow.

Projections through the year 2020 for each of the sources of wastewater flows are set forth in this section.

### 6.3.2 DOMESTIC WASTEWATER

The volume of domestic wastewater is a function of the population of the service area, the water use patterns of the residents, and the amount of water used and returned to the sewer system.

#### Present Population

Residential population, as defined by U.S. Census data, includes standard population as well as students in dormitories and other institutional residents. U.S. Census estimates from July of 1984 showed about 2,046,000 residents within the MWRA's service area.

#### Population Projections

Most population forecasting models study past trends of growth and extrapolate these trends into the future. Many of these models assume that the future population of a community reflects past growth of that community, past growth of some other community, or growth of the region. The true causes of these past trends in population change are natural change and migration. Natural change is composed of births and deaths. Migration reflects the effect of individuals moving into an area less the number moving out of the area. Some population models incorporate the importance of economic factors in establishing migration patterns.

Projections for the residential population in the MWRA service area were based on the review of two regional forecasts listed below:

- Metropolitan Area Planning Council (MAPC)
  Regional Decline or Revival: An Interim Population Forecast for the Boston Metropolitan Area 1980-2010 (1982).

- Metropolitan District Commission (LRWSS)
  Water Supply Study and Environmental Impact Report 2020: Water Demand Projections (1983)

The basis of each forecast is described below:

Metropolitan Area Planning Council (MAPC). The MAPC forecasts were prepared in 1982 to the year 2010 and include 101 communities in eastern Massachusetts. All of the 43 communities in the MWRA service area are included in the MAPC boundary. Review of the regional planning agency population projections is consistent with the required approach to facilities planning population projections set forth by the EPA.

The MAPC model focused on the reformulation of the area's population into smaller household units, including one-parent families and persons living alone. Other factors influencing the analysis include: the shift of women, especially married women, into paid employment; the transformation from manufacturing to a services-based economy and its effects upon family income; the diffusion of workplace and residence to more suburban locations; the continuance of net migration, but at a reduced rate; and the housing prices in the area.

The MAPC has formulated three growth scenarios for the region: low series, mid series and high series, reflecting differing perspectives on future trends in the underlying variables. The mid series projections implicitly assumed that natural increase and net migration would operate in such a manner that the population of the MAPC region would remain the same over time. However, shifts of population would occur within the region. The high and low series project increases and decreases in population of 8 percent compared to mid series population projections by 2010. The high series was based on an increase in fertility and a net migration of zero, while the low series reflected decreased fertility and higher rates of out migration than were assumed in the mid series estimate.

Long Range Water Supply Study. The population forecast set forth in the LRWSS, as prepared in 1983 for the Metropolitan District Commission, was also reviewed for this study. The forecast was based on the Massachusetts Economic Policy Analysis Model developed by the University of Massachusetts, which reflects a direct relationship between the demographic and economic factors of the area. The forecasts are based on the assumption that it is the characteristics of the region's evolving economy (industry composition, business costs, shifting employment, etc.) that will determine the region's future and, through migration, its ultimate population. Important aspects of this model are that it is practically unhindered by past migration patterns and that it focuses on current and projected employment trends as well as the migration patterns associated with those trends.

The study area of the LRWSS consists of a total of 80 communities (44 current MWRA water users and 36 potential future users). Five communities within the MWRA sewer service area (Burlington, Hingham, Reading, Walpole, and Weymouth) were not included in the LRWSS study area. Population figures for these communities were based on estimates developed in previous facilities planning studies.

Conclusion. Figure 6.3.2-1 shows the total MWRA service area population since 1940 along with the MAPC mid and high series population forecasts and the LRWSS forecast. The population projected by LRWSS is approximately 8 percent greater than the MAPC high series model.

For the purposes of this report, we have adopted the MAPC high series total population projections of 2.10 million for the year 2000 and an extrapolated estimate of 2.15 million for the year 2020. The Massachusetts and Boston Metropolitan areas are now going through a change in their underlying economic structure with an inherent uncertainty in the relationship of employment, population, and industrial output. The MAPC model deals with this level of uncertainty to a greater degree than the others because it does not assume that employment in a region forces the population projection for that region. The MAPC high series population projection also provides for recognition of growth in the region that is not factored into the mid series projections. The LRWSS econometric model relies more heavily on the assumption that you live where you work. This assumption is reflected in their higher population projections for 2020.

The sensitivity of this population projection to decisions on wastewater flows is explored in Section 6.3.7.

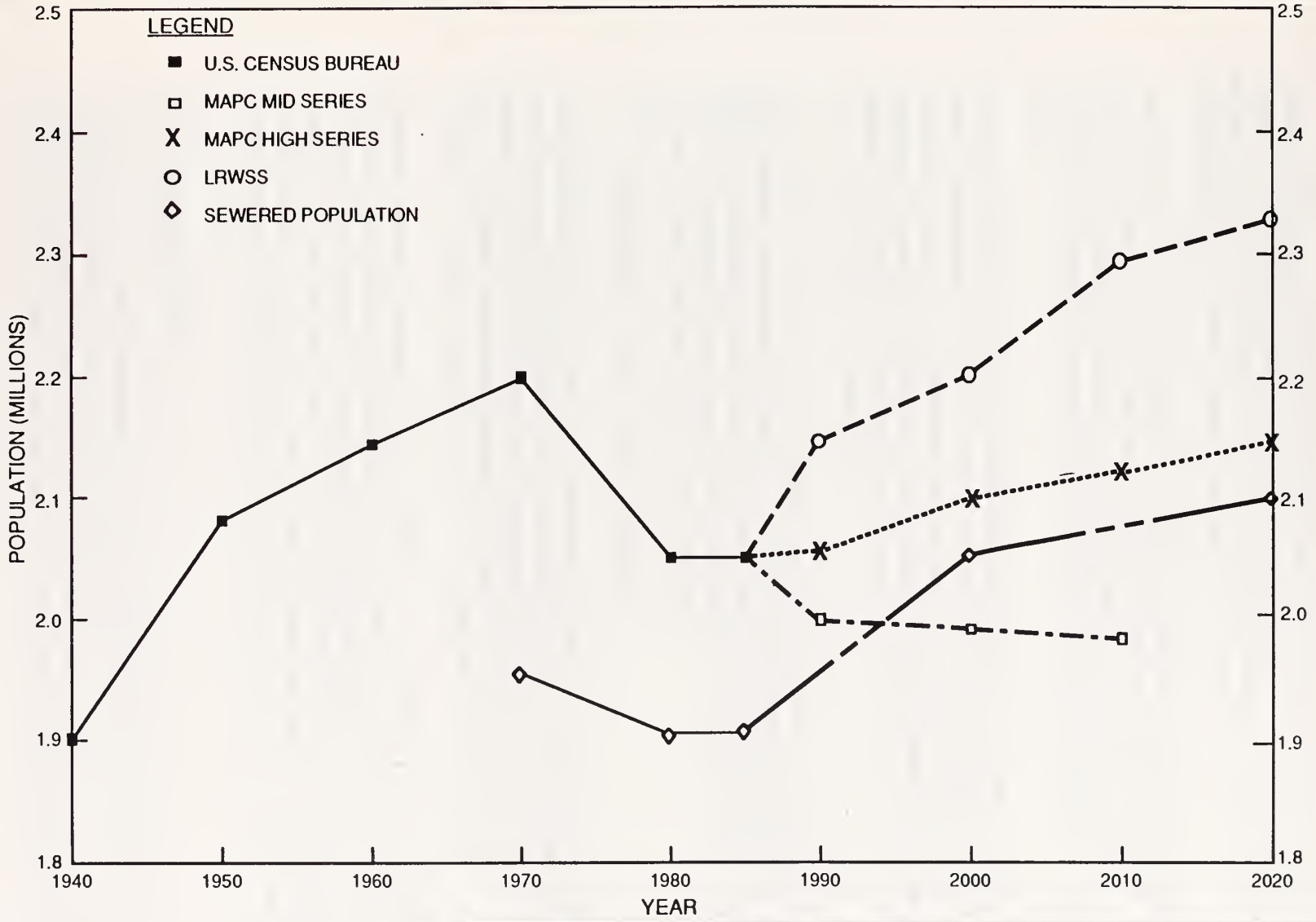
Sewered Population

Based on the 1984 MDC Annual Report, approximately 1.9 million people, or 92 percent of the total population in the service area, were connected to the sewer system. In member communities that are partially sewered, both population changes and projected sewer system extensions have been incorporated in the sewered population projections. As shown in Figure 6.3.2-1, it has been assumed that approximately 98 percent of the total projected population in the design year will be sewered, or 2.1 million people. Not all residents in every community will have sewer service because of cost considerations (construction costs are high for remote areas, high connection and annual charges in areas with existing sewers). Conservatively, it has also been assumed that 98 percent of the total population will be sewered in the year 2000.

Domestic Wastewater Projections

Estimated flow rates of domestic wastewater have been prepared using the residential population projections and estimated water consumption rates of the domestic sector.

The Long Range Water Supply Study (LRWSS) included a detailed analysis of domestic water consumption using 1980 actual consumption data. Average daily domestic per capita water use in the region was found to range from 50-200 gallons per capita per day (gpcd), primarily a




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 6.3.2-1**
**POPULATION PROJECTIONS FOR MWRA SEWERED SERVICE AREA**

function of housing type (ie. single family vs.multi-family, small lot vs. large lot) and the number of persons per household. The current average domestic water consumption rate in the MWRA service area was estimated at 76 gpcd. This estimate includes a 6 percent allowance for the under-registration of domestic meters as estimated by the LRWSS.

The LRWSS estimated that approximately 12 percent of the domestic consumption was seasonal use such as lawn watering, filling of pools, etc. In addition, a small percentage (3 percent) of the water was not returned to the system. Thus, 85 percent of the domestic water used is expected to be discharged to the sewer system as domestic wastewater, or 65 gallons per capita per day.

The LRWSS projected a small reduction in domestic consumption in future years, primarily as a result of plumbing code revisions, increased user charge, and conservation efforts. Because the projected reduction in consumption is small, the future per capita consumption used to estimate future domestic wastewater flows from residential sources is assumed to be the same as observed in the 1980 data. The sensitivity of this projected flow rate to the total wastewater flow projection is analyzed in Section 6.3.7.

Future domestic wastewater flows from residential sources were estimated by applying a per capita wastewater contribution of 65 gallons per capita per day (85 percent of the expected per capita water consumption) to the sewered population projections, summarized in the previous section. Thus the total estimated domestic wastewater expected from residential sources is 133 mgd and 136 mgd in the years 2000 and 2020, respectively.

### 6.3.3 NONDOMESTIC WASTEWATER PROJECTIONS

Nondomestic wastewater is contributed to the Authority's system from the business activities which take place within the service area. These include process wastewater associated with manufacturing activities, institutional activity, employee-related sanitary wastes, and wastes which are incidental to the service provided by the business. An example of the latter category is the wastewater produced by visitors to the region who occupy hotel rooms.

Estimated volumes of wastewater have been projected over the planning period by subdividing the nondomestic user class into two categories, major and minor, and projecting the contribution from each class separately. The major category is comprised of the 667 major users of the Authority's system. Records of these users are available from the Authority's Industrial Waste Control program files. The minor users are generally commercial business, office buildings and service companies. Estimates of flows from those users have been based on predicted employment in the service area.

#### Major Nondomestic Users

Data for flows from major nondomestic users has been taken from the 1985 industrial waste records of the Authority. This information is collected by the Authority for use in the pretreatment program, and as part of the Authority's sewer use charge billing system. The types of companies included in the major category include manufacturing establishments, large

institutional users, such as hospitals and schools, and large service companies such as laundries.

Based on the LRWSS and previous facilities planning reports prepared for the MWRA service area, the rate of wastewater flow for the major nondomestic users in the year 2020 has been projected to remain constant at the 1985 discharge level of 43 mgd. While individual companies may undertake steps to reduce their water consumption, or move their operations, it cannot be assumed that all of the major users were at optimum production levels in 1985. Thus, while some existing users may decrease the wastewater discharge rates below existing levels, others may increase above existing levels in response to increased demand for their goods and services, and new discharges may be added.

Minor Nondomestic Users

The category of minor nondomestic users includes all other business activity which takes place in the service area. Unlike the major nondomestic category, which includes a substantial flow component associated with the manufacturing process, the wastewater contribution of the minor nondomestic category is predominantly driven by employee usage. Thus, future levels of minor nondomestic flows have been projected based on future employment in the Authority's service area and assumptions concerning employee water use patterns. While there are limitations in stating a "gallon per employee" figure for wastewater discharge, such a number can be related to employment statistics and employment projections to project wastewater discharge.

Existing employment for the minor nondomestic class of dischargers has been estimated using employment information collected by the Massachusetts Division of Employment Security (DES), and data on employment of the major nondomestic users available through the Authority's Industrial Waste Program. The difference between the two represents the estimated existing minor nondomestic users. The DES data were adjusted upwards by 8 percent to include workers not covered under the Employment Security Act. Current (1985) adjusted DES information shows about 1,432,000 employees working in the service area. Major company employment for the same year has been estimated at 335,000 employees, leaving 1,097,000 as the 1985 estimated minor company employment.

Projections of future employment in the service area have been estimated based upon assumed rates of growth of the economy of the service area presented in previous studies.
Future levels of employment within the greater Boston metropolitan area have been projected by several different organizations. The Boston Edison Company (BECo) has recently forecast employment for its service district through the year 2000. The BECo Service District, which comprises 47 municipalities in the Greater Boston area, overlaps much of the MWRA's sewer service area. Of the 43 communities served by the Authority, 28 are also included in the BECo service territory. The major differences between the service areas exist in the northeast, southeast, and in the western boundaries of the MWRA's service area. Overall, BECo has projected a total increase in employment of approximately 40 percent between 1985 and the year 2010.

The Massachusetts Division of Employment Security has recently forecast changes in employment for the state as a whole through the year 1995. These projections indicate an increase in statewide employment of approximately 15 percent over 1985 employment. Additionally, Arthur D. Little, as part of the LRWSS studies, prepared employment forecasts through the year 2020 for the state as a whole and for various subregions of the state. These forecasts predicted an increase in statewide employment of approximately 20 percent between 1980 and the year 2000, and an additional 21 percent between the years 2000 and 2020.

Since the Arthur D. Little forecast is the only estimate for MWRA and estimates of employment through the year 2020, the results of that study have been adopted for this report.

Adjustments have been made to the forecasted employment to reflect the actual 6.5 percent growth in employment in the MWRA service area which occurred between 1980 and 1985. Accordingly, from 1985 through 2020 it is expected that employment will rise by 30 percent over 1985 levels. Minor company employment is estimated to be 1,426,000 in the design year.

The wastewater contributions associated with total employment in the year 2020 have been based on an allowance of 30 gallons per capita per day for all employees except those engaged in the hotel and food services businesses. For these last two classes of business, which comprise about 1.5 percent and 7 percent of the employment in the region respectively, special allowances have been made to account for the water-intensive nature of the business. Allowances of 150 gal/employee/day for hotels and 180 gal/employee/day for food service have been used for projecting flows. Minor nondomestic flows are estimated at 46 mgd, 50 mgd and 60 mgd respectively in the years 1985, 2000 and 2020.

The average base domestic and nondomestic wastewater projections for the years 1985 to 2020 are shown in Table 6.3.3-1. Maximum daily flows and peak hour flows were based on peaking factors from the Water Pollution Control Federation Manual of Practice No. 9. The total system maximum daily flow of 323 mgd was based on peaking the sums of the total North and South systems average daily flows rather than adding the maximum daily flows for both systems. These estimates do not include infiltration and inflow, which are discussed in the following section.

### 6.3.4 INFILTRATION AND INFLOW

Infiltration and inflow (I/I) to the sewer system is the sum of infiltration (groundwater that enters the system through cracks in pipes and manholes) and inflow (water that reaches the system through direct connections during and after storm events). Inflow is delivered to the system by roof leaders, sump pumps, catch basins, system defects such as missing or broken manhole covers and frames, and through inoperable or leaking tide gates.

Infiltration/Inflow (I/I) and direct stormwater runoff account for a significant amount of flow in the MWRA sewer system as depicted by the 1984 flow data, shown in Figure 6.3.4-1. Seasonal flow variations are a direct response to variations in I/I. The flow data from 1984, a reasonably wet year, is presented as a 30-day moving average of flow at Deer Island and Nut

## TABLE 6.3.3-1

## EXISTING AND PROJECTED WASTEWATER FLOWS

**(mgd)**

| | 1985 | 2000 | 2020 |
|---|---|---|---|
| Domestic | 123 | 133 | 136 |
| Nondomestic | | | |
| Minor Users | 46 | 50 | 60 |
| Major Users | 43 | 43 | 43 |
| Total | 212 | 226 | 239 |

Notes:

1) Domestic wastewater flow based on sewered population and wastewater production of 65 gpcd.

2) Minor nondomestic wastewater flow based on employment trends with wastewater production of 30 gallons per employee per day for all employees except those engaged in the hotel and food service businesses.

3) Major nondomestic wastewater flow assumed static over the planning period.

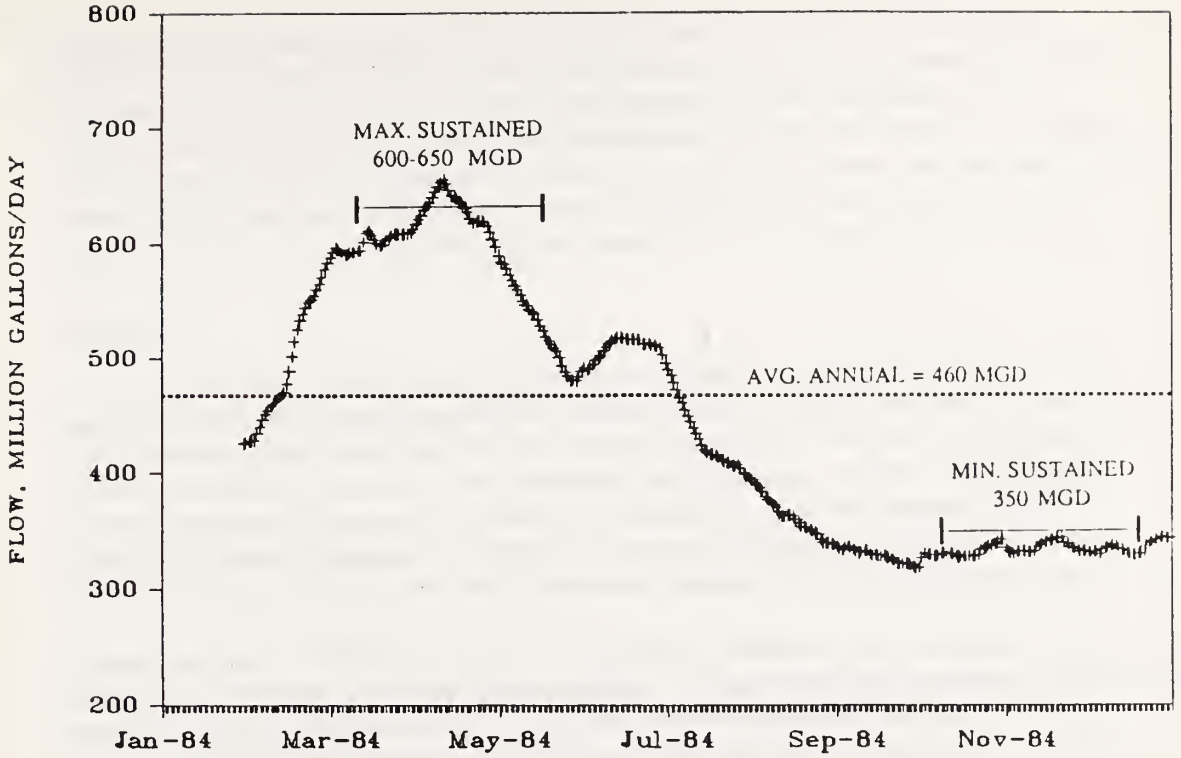
Island in Figure 6.3.4-1. As shown, the months February through May have notably higher flows than the remainder of the year due to higher groundwater elevations which result in increased I/I. Due to this phenomenon, I/I flows were estimated for two periods: high groundwater conditions (February - May); and low groundwater conditions (June - January). To determine the magnitude of I/I in the MWRA system, historic flows entering the Deer Island and the Nut Island Plants were examined.

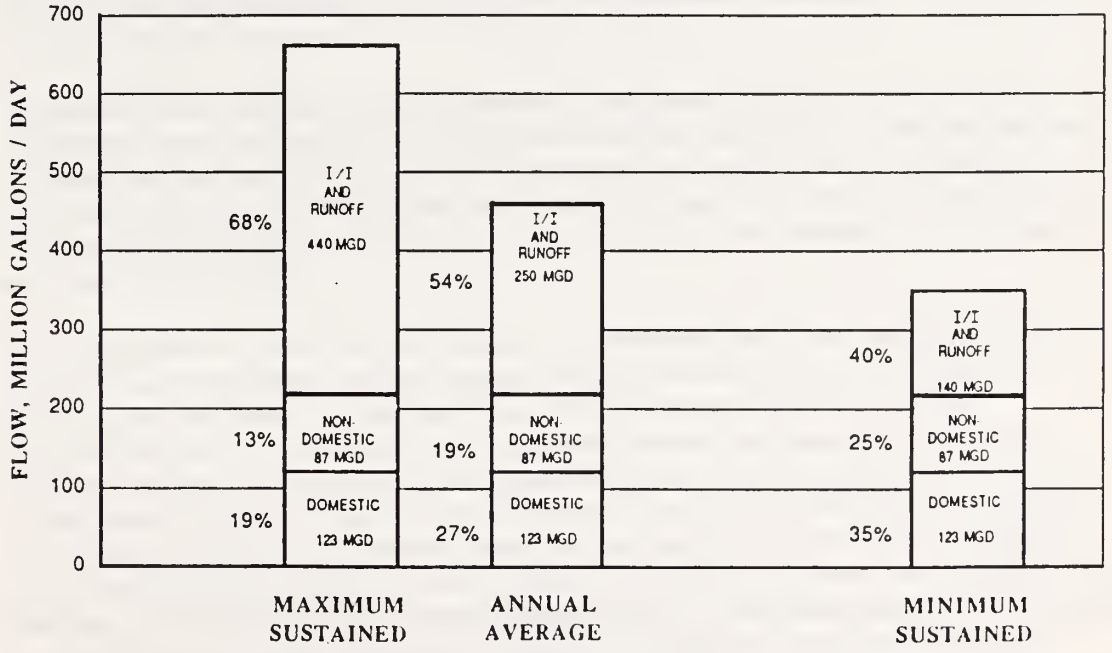
North System

Estimation of I/I flows in the North service area is complicated by several factors. First, a portion of the service area has combined sewers, so analysis of total flows by the components of wastewater, I/I, and stormwater runoff is difficult. Second, the Deer Island Main Pumping Station that pumps most of the flow to the Deer Island plant has been operating with reduced capacity since the late 1970's. For extended periods the plant has had only five of nine pumps available. This requires wastewater flows to be "choked" at the headworks facilities under high flow conditions, resulting in overflows at CSO treatment facilities and other overflow points. Therefore, records of flows at the headworks and the treatment plant are not reliable indicators of total plant flow and require adjustments to be used for estimating I/I flows.

To determine I/I during low groundwater conditions the following method was used. The average daily flows obtained from the Deer Island plant records for the months of June 1984 through January 1985, June 1985 through January 1986 and June 1986 through January 1987 were examined. Flow during these low groundwater months averaged about 260 mgd at Deer Island. During these periods only a small amount of flow was bypassed. Since average domestic and nondomestic wastewater flows were estimated at about 134 mgd, the difference of 126 mgd was estimated to be the I/I component. To determine I/I during maximum conditions, flows on maximum days were compared to flows on average days. Domestic and nondomestic wastewater flows were assumed to be average daily flows. Data from days without rainfall were used to exclude storm flows. A peaking factor of 1.25 for maximum I/I compared to average I/I was determined from the data. The resulting maximum I/I flow of 158 mgd was also used as the peak hour I/I rate.

The method used to calculate I/I flows during periods of high groundwater took into account flows not reaching the Deer Island plant. The magnitude of this bypassed flow during storm periods was determined by an examination of rainfall data during three wet springtime months, March and April 1984 and April 1987. By assuming that 100 percent of the runoff was captured for the 12,900 acre combined sewer area, a maximum additional flow of 40 mgd was estimated. During these months only about 380 mgd reached the plant according to plant records, so an estimated average daily flow of 420 mgd would have reached the plant if more pumping capacity had been available. The I/I flow was determined by the difference between the adjusted total flow, 420 mgd, and the base wastewater flow of 134 mgd. This results in an average day high groundwater period flow of 286 mgd, or slightly more than twice the average I/I flows during low groundwater conditions. Maximum day high groundwater I/I flows were determined by estimating a peaking factor similar to the method used for low groundwater conditions. The peaking factor for the North System was determined to be about 1.35, for a maximum I/I flow of about 390 mgd. As noted earlier, infiltration rates respond to groundwater levels and,




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 6.3.4-1**
**1984 FLOW DATA**

therefore, do not change significantly from day to day. Inflow, however, varies with the magnitude of storm events, changing considerably from day to day and significantly from hour to hour during storms. Because the amounts of infiltration and inflow, respectively, are not known on an individual basis, peak hour and maximum day I/I quantities were taken to be equal. Existing average and maximum/peak hour I/I flows for the North and South service areas for both low and high groundwater conditions are shown in Table 6.3.4-1. Later in this section, the actual amount of I/I to be accepted at the Deer Island Plant will be established.

South System

The South service area represents all the service area tributary to the Nut Island plant. The South System has only a small percentage of combined sewers, but data from the Nut Island plant shows that storm events cause large increases in flows to the plant. The Nut Island plant has an influent pumping station with a rated capacity of about 280 mgd. However, actual capacity of the pumping station is less than this amount. When flows exceed the available pumping capacity, the excess is bypassed. The bypassed quantities historically have not been recorded, but recent flow measurements show the bypasses to be substantial during major storm events.

To determine the I/I contribution during low groundwater conditions (June to January), plant records from 1984 through mid-1987 were examined. Average daily flows were about 100 mgd. To estimate I/I flows we assumed that few, if any, bypasses occurred during this period. Based on estimates of connected population and major and minor nondomestic contributions, the base wastewater flow during that period was approximately 75 mgd. The difference between the total (100 mgd) and the base (75 mgd) was 25 mgd and was taken to be the average I/I during periods of low groundwater conditions.

To determine I/I on maximum days, total wastewater flow on maximum days in any given low groundwater month was compared to average low groundwater monthly flows. The base flow was subtracted from each and peaking ratios were developed. The maximum day I/I peaking ratio used for the South System was 5.0. This ratio was also used for peak hour conditions. Therefore, maximum day and peak hour I/I estimates for the South System were calculated to be 125 mgd for low groundwater conditions.

For high groundwater conditions, data for three wet springtime months were analyzed (March and April 1984 and April 1987). Average daily non-rainfall flow during this period was 220 mgd. Subtracting the base flow (75 mgd) results in an estimated average I/I flow of 145 mgd. Maximum and peak hour I/I flows cannot be estimated from the data because of springtime bypasses. Therefore, data from the recently completed South System Modeling Study conducted for the MWRA were used. During late March and early April 1987, when nearly 8 inches of rainfall was recorded during a seven day period, the flow recorded at a flow meter on the High Level Sewer (HLS) just upstream of the Braintree-Weymouth Pumping Station was 350 mgd. The flow from the Braintree-Weymouth pumping station during the same period was about 45 mgd. Only about 250 mgd was received at the plant. Therefore, the remainder was bypassed or caused surcharging. Subtracting the 75 mgd baseflow from the 395 mgd total flow results in a maximum I/I contribution of 320 mgd. This estimate was also used for peak hour conditions.

TABLE 6.3.4-1

EXISTING INFILTRATION AND INFLOW FOR NORTH AND SOUTH SERVICE AREAS

Low Groundwater Conditions

| | Average | Peaking Factor | Maximum Day and Peak Hour |
|---|---|---|---|
| North Service Area | 126 | 1.25 | 158 |
| South Service Area | 25 | 5.0 | 125 |
| Total | 151 | 1.9 | 283 |

High Groundwater Conditions

| | Average | Peaking Factor | Maximum Day and Peak Hour |
|---|---|---|---|
| North Service Area | 286 | 1.35 | 390 |
| South Service Area | 145 | 2.2 | 320 |
| Total | 431 | 1.65 | 710 |

This estimate was then compared to the results of the South System Modeling Study.

Since June 1986, flow meters have been placed at a number of locations in the HLS, and on several occasions storm conditions have caused surcharging along the HLS. The DWPC has established a "standard storm" for determining the amount of inflow that should be accommodated in the design of sewers. The standard storm has a duration of 6 hours, a recurrence interval of one year and produces a rainfall of 1.7 inches. The area tributary to the HLS was modeled and the total routed inflow averaged about 90 mgd over a one-day period. The peak inflow during the period was 155 mgd. To estimate the total flow from a standard storm, the 90 mgd of inflow was added to the 220 mgd of average daily baseflow. The resultant standard storm is 310 mgd. Subtracting the 75 mgd baseflow results in a maximum day I/I contribution of 235 mgd. To determine peak hour I/I flows, the peak hour inflow of 155 mgd was added to the base flow of 220 mgd, resulting in a total flow of 375 mgd and an I/I flow of 300 mgd.

This estimate of a peak hour standard storm (375 mgd) is higher than the 330 mgd standard storm presented in the South System Modeling Study because the baseflow of 175 mgd used in that study considered average springtime conditions rather than the more conservative wet springtime months used for this report. It should be noted that several storms in the last year have exceeded the standard storm flow of 330 mgd, indicating recurrence intervals of greater than one year. In fact, the April, 1987 storm is considered a 25 year event.

The estimated maximum day I/I flow of 320 mgd, determined from the April, 1987 storm, is considerably higher than the 235 mgd maximum day I/I flow determined from the standard storm. As will be described in the next section, to eliminate surcharges in the High Level Sewer, the maximum day I/I flow will have to be reduced. Existing infiltration and inflow estimates for the South System are shown in Table 6.3.4-1.

Infiltration and Inflow Summary

Base wastewater flows (domestic and nondomestic) for the year 2020 were added to I/I flows to determine the non-storm wastewater flow to the plant. Stormwater flows will be discussed in the next section. In the North System the transmission system was originally sized to accept storm flows so that all nonstorm flows will reach Deer Island with a considerable amount of additional capacity available for storm conditions. Table 6.3.4-2 shows North System flows without stormwater.

Table 6.3.4-3 shows South System flows for low and high groundwater conditions. At low groundwater conditions all flows reach Nut Island. However, at high groundwater conditions, maximum daily flows and peak hour flows exceed the unsurcharged capacity of the HLS. The South System Modeling Study determined that the HLS has a maximum hydraulic capacity of 360 mgd without surcharging. Based on analysis of I/I flows during the April, 1987 storm, maximum

**TABLE 6.3.4-2**

**DESIGN YEAR**

**NORTH SYSTEM FLOWS (MGD)**

| | Average | Maximum Day | Peak Hour |
|---|---|---|---|
| Low Groundwater Conditions | | | |
| Wastewater | 154 | 208 | 246 |
| I/I | 126 | 158 | 158 |
| Total | 280 | 366 | 404 |
| High Groundwater Conditions | | | |
| Wastewater | 154 | 208 | 246 |
| I/I | 286 | 390 | 390 |
| Total | 440 | 598 | 636 |
| Hydraulic Capacity Of Transmission System | --- | 913 | 913 |

**TABLE 6.3.4-3**

**DESIGN YEAR**

**SOUTH SYSTEM FLOWS (mgd)**

| | Average | Maximum Day | Peak Hour |
|---|---|---|---|
| Low Groundwater Conditions | | | |
| Wastewater | 85 | 120 | 170 |
| I/I | 25 | 115 | 180 |
| Total | 110 | 235 | 350 |
| High Groundwater Conditions | | | |
| Wastewater | 85 | 120 | 170 |
| I/I | 145 | 235 | 300 |
| Total | 230 | 355 | 470* |
| Hydraulic Capacity of HLS | | | 360* |
| Flow Exceeding Capacity | | | 110* |

*The hydraulic capacity of the HLS is sufficient to accept the Division of Water Pollution Control's design storm. Thus, flow exceeding capacity (110 mgd) is not a flow that requires treatment by existing regulations.

flows of up to 440 mgd may be generated in the South System. Excess flow at maximum day conditions is 80 mgd.

In order to prevent surcharging in the South System interceptors, I/I flows must be ubstantially reduced. The DWPC is now examining the results of I/I studies in the 21 communities in the South System. Data have yet to be standardized, but preliminary estimates show that it is reasonable to expect that sufficient I/I (especially inflow) could be removed to eliminate excess flow. The MWRA has recently established a task force to develop a policy on infiltration/inflow management. It is expected that the goal of this policy will be the elimination of surcharges and bypasses along the HLS.

For this project we believe it is prudent to plan for new facilities with a capacity of 360 mgd, which is equal to the existing hydraulic capacity of the HLS. This design requires the elimination by 1995 of approximately 110 mgd of I/I during peak hour conditions. As noted earlier, this sewer capacity will accommodate flows associated with the DWPC's design storm. This decision should be re-examined when the results of the DWPC I/I study are available and as the I/I management policy is fully developed.

This decision should also be reexamined in 1988 when the Braintree-Weymouth Pumping Station Environmental Impact Report is completed. As noted above, the Braintree-Weymouth Pump Station now discharges flow to the HLS. Under an alternative plan being considered by the Authority, flows from the Braintree-Weymouth interceptor would discharge directly to the Nut Island headworks. The South System Modeling Study examined the capacity of the HLS with the Braintree-Weymouth flows removed and with greater flows in the upstream reaches of the sewer. Under this alternative the hydraulic capacity of the HLS is limited to 325 mgd without surcharging because of hydraulic limitations in upstream reaches of the sewer. The flow from Braintree-Weymouth is about 30 mgd at average conditions and 60 mgd at peak conditions. Therefore, the total flow reaching Nut Island might increase to 385 mgd in the future if Braintree-Weymouth flows are directed to Nut Island. For the present we recommend planning for a 360 mgd capacity for the Nut Island headworks and inter-island conduit. If the Braintree-Weymouth flows are directed to Nut Island, the capacity need only be increased by about 7 percent at the headworks and only about 2 percent at the Deer Island Plant. These changes can be accommodated during facilities design.

### 6.3.5 STORMWATER

Within the communities of Boston, Brookline, Cambridge, Chelsea and Somerville are approximately 12,900 acres with combined sanitary and storm sewers. During storms, runoff reaches the plant via these combined sewers. Stormwater runoff in excess of the transmission capacity of the sewer system is discharged to nearby water bodies as combined sewer overflow (CSO). The maximum capacity for headworks receiving stormwater runoff, and for the proposed

headworks at Nut Island serving the South System service area, is shown below.

| | Transmission System Capacity (mgd) |
|---|---|
| Ward Street | 256 |
| Columbus Park | 182 |
| Chelsea Creek | 350 |
| Winthrop Terminal | 125 |
| Subtotal North System | 913 |
| Subtotal South System | 360 |
| Total | 1273 (rounded to 1270 in subsequent tables) |

As shown in Table 6.3.5-1, maximum daily non-storm flows will range from 600 mgd to 950 mgd, depending on the time of the year. Since the maximum hydraulic capacity of the transport system is approximately 1270 mgd, then from 320 to 550 mgd of capacity is available to accept stormwater flows in the North system at maximum day wastewater flow conditions.

Recent proposals for combined sewer overflow management envision storage and pumpback of storm flows to the plant. Flows are planned to range from 200 to 300 mgd over a period of 1 to 2 days. The flow projections used for this study include ample capacity for pumpback of stored CSO.

### 6.3.6 TOTAL WASTEWATER FLOWS

As shown in Table 6.3.5-1, average daily flow during low groundwater conditions at design year is estimated at 239 mgd. Including infiltration and inflow, the total average daily flow during low groundwater conditions is estimated at 390 mgd. At high groundwater conditions, the flow is estimated to average 670 mgd. Assuming a four-month period of high groundwater and an eight-month period of low groundwater, the annual average flow during non-storm events is approximately 480 mgd. Table 6.3.6-1 shows design year average, maximum and peak hour flows under both low groundwater and high groundwater conditions. Also shown on this table is the total capacity in the transmission system and the treatment facilities available for stormwater flow under the various conditions.

### 6.3.7 SENSITIVITY ANALYSIS

The flow estimates presented in the previous sections were developed from the best available data. The sensitivity of variations in these estimates and their effects on plant sizing and performance were analyzed.

Wastewater flow estimates for the domestic sector were based on the regional population projections for the service area, combined with estimated per capita water consumption. The domestic wastewater flow represents about 29 percent of the total average day flow in the year 2020. Therefore, variations in domestic flows will not significantly impact total flow

TABLE 6.3.5-1

SUMMARY OF AVERAGE DAILY (NONSTORM) FLOW BY YEAR (mgd)

| | 1985 | 2000 | 2020 |
|---|---|---|---|
| Total Population | 2,050,000 | 2,100,000 | 2,150,000 |
| Sewered Population | 1,900,000 | 2,060,000 | 2,100,000 |
| Domestic Wastewater | 123 | 133 | 136 |
| Nondomestic Wastewater | | | |
| Minor Users | 46 | 50 | 60 |
| Major Users | 43 | 43 | 43 |
| Subtotal | 212 | 226 | 239 |
| Infiltration/Inflow (Low Groundwater Conditions) | 151 | 151 | 151 |
| Total | 363 | 377 | 390 |
| Infiltration/Inflow (High Groundwater Conditions) | 431 | 431 | 431 |
| Total | 643 | 657 | 670 |
| Average Annual Conditions | 460 | 470 | 480 |

## TABLE 6.3.6-1

## DESIGN YEAR (2020) FLOWS (mgd)

| | Low Groundwater Conditions | | | High Groundwater Conditions | | |
|---|---|---|---|---|---|---|
| | Average | Maximum | Peak Hour | Average | Maximum | Peak Hour |
| Non-Storm Conditions | | | | | | |
| Total Flow | 390 | 600 | 660 | 670 | 950 | 1000 |
| Storm Conditions | | | | | | |
| Wastewater Flow | 390 | 600 | 660 | 670 | 950 | 1000 |
| Storm Capacity | --- | 550 | 550 | --- | 320 | 270 |
| Total Flow | 390 | 1150 | 1210 | 670 | 1270 | 1270 |

(Annual Average Flow is 480 mgd based on 4 months of high groundwater conditions and 8 months of low groundwater conditions.)

arriving at the plant. The sewered population projection could vary if additional outlying communities become members of the MWRA sewer district (i.e., Lynnfield in the North System and Dover, Sharon, Sherborn, and Southborough in the South System). The estimated additional sewered population in 2020 is no more than 5,000 for the North System and 14,500 for the South System. These represent about an additional one percent in the total service area population. Applying the per capita wastewater production rate of 65 gpcd results in only an additional 1.3 mgd. Increasing the projected population for the entire service area by 8 percent, representing the LRWSS population estimate, results in an increase of only 11 mgd over the annual average of 480 mgd. According to the LWRSS, reduction in domestic wastewater flow due to conservation efforts, increased rates, and education could effectively reduce the per capital wastewater production from 65 gpcd to 60 gpcd which equates to a reduction of 10.5 mgd.

The total average nondomestic flow has been estimated at 103 mgd which represents approximately 21 percent of the total average annual flow in the year 2020. A ten percent variation in this flow due to increased industrial or manufacturing activity, or increase in employment in the service area, will not significantly impact the total flow estimate. As presented in Section 6.3.4, the total flows are most sensitive to the volume of infiltration/inflow -- which is the most difficult to quantify, but is however, manageable.

System management can be structured to compensate for any unanticipated increase in domestic or nondomestic wastewater flow through a small reduction in infiltration/inflow (particularly inflow), thus maintaining a relatively static rate of average flow to the plant throughout the planning period.

## 6.4 CONVENTIONAL POLLUTANT LOADS

### 6.4.1 GENERAL

Secondary treatment plants remove oxygen-demanding substances and suspended matter from the waste stream. These pollutants are measured as five-day biochemical oxygen demand (BOD) and total suspended solids (TSS), respectively. Discharge permits issued to treatment plants by state and federal regulatory agencies specify the maximum concentration of BOD and TSS which may be discharged by the plant.

The discharge permit recognizes that there is inherent variability in the day-to-day loadings and operation of secondary treatment facilities. Thus, permit limits are specified in terms of concentration and time. MWRA's NPDES permit for secondary treatment has specified that the discharge must contain no more than 30 milligrams per liter (mg/l) BOD or suspended solids on a monthly average basis, not more than 45 mg/l of either pollutant on a weekly average basis, and not more than 50 mg/l of either pollutant on a daily basis. In order to properly design the wastewater plant to meet these limits, the expected conventional pollutant loading entering the plant has been estimated for the design year 2020.

Estimates of future year average annual pollutant loadings were developed using two steps. First, the current plant loadings were ascertained from historical records and recent sampling data. Second, loading allowances were made for the capture of existing dry weather overflows

and CSO management as well as allowances for increased solids contributed to the plant as a result of growth in domestic and nondomestic flows. Additional loadings equaling 10 percent of the influent loads were included as an allowance for sidestreams from sludge processing in the sizing of individual unit processes.

### 6.4.2 TOTAL SUSPENDED SOLIDS LOADS

Existing plant loadings were computed using the combined operating records of the Deer and Nut Island treatment plants for the period from January, 1984 through May, 1986, and the sampling programs conducted as part of this facilities plan. From plant records the average loading on non-rainfall days was calculated to be 444,000 pounds TSS. The sampling program, conducted in the Fall of 1986 and the Spring of 1987 at the four headworks facilities and the two treatment plants, was designed to characterize the wastewater to be treated. The Fall 1986 sampling program was conducted in a period of essentially no rain, and observed an average influent TSS load of 445,000 pounds per day. Thus the sampling program data showed close agreement with the historic operating data from nonrainfall periods and, therefore, was considered representative of the current average TSS load. During the Spring 1987 sampling period rainfall was frequent and days with no rainfall could not be interpreted as dry weather flows because of snow melt conditions.

Dry weather overflows (DWO) were shown to exist in the sewer system tributary to the Authority's treatment plants. As part of the 1982 CSO plan, the volume of dry weather overflow was estimated at 25 million gallons per day. Since the date of the CSO report, steps have been taken to reduce DWOs in the service area. A study completed for MWRA in January 1987 estimated the range of dry weather overflows at 0.3 to 1 mgd. The capture of 1 mgd of DWO would result in an additional 1300 pounds of suspended solids based on a concentration of 155 mg/l of TSS as measured at the Deer Island Plant.

Increases in both domestic and nondomestic wastewater are expected to occur as a result of increased population and business activity in the service area and as a result of the extension of sewers within the serviced communities. Projections of these two activities indicate an increase of approximately 27 mgd of wastewater flow. At an estimated concentration of 300 mg/l suspended solids, an increase in loadings of 67,500 pounds over current levels is expected from these additional flows. Therefore, total suspended solids loading is expected to reach approximately 515,000 lb/day during average non-storm days.

### 6.4.3 BOD LOADS

Projections for average day BOD loadings were developed in a manner similar to that used to project suspended solids loads. Existing plant loadings were computed from the operating records of the Deer and Nut Island treatment plants for the period January of 1984 through May of 1986. The total plant average daily loading of BOD on nonrainfall days was 447,000 pounds. The sampling program conducted in Fall of 1986 as part of this facilities plan showed an average daily BOD loading of 500,000 pounds. Because the Fall 1986 sampling was conducted during a period of very low I/I and essentially no stormwater flows to the plant, and is considered reliable data, the BOD loading for that period was considered representative of

current average conditions.

As described earlier, dry weather overflows were shown to exist in the sewer system tributary to the Authority's treatment plants. The allowance of 1 million gallons per day would contain approximately 1,500 pounds of BOD based on a concentration of 180 mg/l of BOD as measured at the Deer Island Plant.

Increases in both domestic and nondomestic wastewater are expected to occur as a result of increased population and business activity in the service area and as a result of the extension of sewers within the serviced communities. Projections of these two activities indicate an increase of approximately 27 mgd over current wastewater flows. At an estimated concentration of 300 mg/l of BOD, an increase in the BOD load of 67,500 pounds over the current level is expected.

BOD loadings are expected to reach 570,000 lb/day during average non-storm periods.

### 6.4.4 STORMWATER LOADS

Estimates for conventional pollutant loads from stormwater were developed by analyzing pollutant mass accumulation over the combined sewer service area. The accumulation of pollutants on the land is primarily a function of land use and time between storms. During a major storm event, runoff carries pollutants on the land surface into the combined sewer system. After the storm event, the mass of pollutants begins to accumulate again. The accumulation continues until the next storm event when all or some of the pollutant mass is carried by runoff to the combined sewer system.

For TSS, the maximum accumulation over the 12,900-acre combined sewer service area average 40 to 50 pounds per acre. This estimate is derived from an average of values ranging from about 75 pounds per acre for commercial and industrial land uses, to about 40 pounds per acre for residential land, and 10 pounds per acre for open space. These are all maximum values developed through calibration of combined sewer models for Boston and other urban areas. The modeling results have also shown that maximum BOD accumulation is generally about 40 percent that of TSS. The total stormwater TSS and BOD loadings conveyed to Deer Island is dependent on the capacity of the interceptor system. For this analysis 60 to 80 percent of the maximum pollutant load was assumed to reach the plant. The calculated total stormwater TSS and BOD loadings are approximately 400,000 lb/day and 165,000 lb/day respectively. These estimates have been compared to plant loadings during the Spring 1987 sampling program and have been found to be reasonable.

As noted earlier, recent proposals for CSO management envision storage and pumpback of stormflow to the plants. The TSS and BOD loadings of 284,000 lb/day and 162,000 lb/day respectively used in these proposals fall within the allowances used in this study.

### 6.4.5 LOAD VARIABILITY

Table 6.4.5-1 shows the variability in conventional pollutant loadings for the planning period

**TABLE 6.4.5-1**

**SUMMARY OF CONVENTIONAL POLLUTANT LOADINGS**
**(1000 lbs/day)**

| | 1990 | 2000 | 2010 | 2020 |
|---|---|---|---|---|
| BOD (1000 lb/day) | | | | |
| Average Day | 505 | 537 | 554 | 570 |
| Maximum Day | 1010 | 1074 | 1108 | 1140 |
| Maximum Day with Storm | 1175 | 1239 | 1273 | 1305 |
| Maximum Three Days | 758 | 806 | 831 | 855 |
| Maximum Month | 657 | 698 | 720 | 741 |
| TSS (1000 lb/day) | | | | |
| Average Day | 450 | 481 | 498 | 515 |
| Maximum Day | 945 | 1010 | 1046 | 1080 |
| Maximum Day with Storm | 1345 | 1410 | 1446 | 1480 |
| Maximum Three Days | 720 | 770 | 797 | 824 |
| Maximum Month | 585 | 625 | 647 | 670 |

1990 to 2020. Peaking factors for maximum day, maximum three-day and maximum month were based on Nut Island plant records of 1975 through 1980 as reported in the Commonwealth of Massachusetts Nut Island Wastewater Treatment Plant Facilities Planning Project, Phase I, Site Options Study as follows:

| | Non-Storm Peaking Factors | |
|---|---|---|
| | BOD | TSS |
| Maximum Day | 2.0 | 2.1 |
| Maximum Three Days | 1.5 | 1.6 |
| Maximum Thirty Days | 1.3 | 1.3 |

These peaking factors are typical of large municipal wastewater treatment facilities and are considered representative of nonstorm conditions in both the North and the South Systems.

Maximum day with storm includes allowances for stormwater loads to the plant. There is no correlation between plant flow and load, therefore the pollutant loading from stormwater may be carried with an average flow of a few hundred mgd or with a flow of 960 mgd as discussed in Section 6.3.5. For the purpose of quantifying loadings to the plant, the maximum quantity of stormwater BOD (165,000 lb/day) and TSS (400,000 lb/day) load is shown for each storm event.

### 6.4.6 WASTEWATER CHARACTERIZATION

The results of the Fall 1986 and Spring 1987 sampling programs were used to determine the general character of the MWRA wastewaters. Characterization parameters for Deer Island, Nut Island, and combined Deer Island and Nut Island flows are presented in Table 6.4.6-1. Parameters for typical domestic wastewaters are also presented.

The Deer Island and Nut Island wastewaters are essentially identical in organic characteristics and both are typically domestic in nature. The wastewaters are highly biodegradable and sufficient nutrients are present in the raw wastewaters for biological treatment.

## 6.5 NON-CONVENTIONAL POLLUTANT LOADINGS

### 6.5.1 GENERAL

Non-conventional pollutants are those constituents which can be toxic when found in excessive concentrations. They include heavy metals, volatile organics, pesticides and a suite of other materials. These non-conventional pollutants are classified under the EPA's Priority Pollutant List (PPL) and the Hazardous Substances List (HSL). The PPL and the HSL cover metals as well as organics. For the most part, the HSL parameters overlay those found in the PPL, with some exceptions. The chemical categories within these classifications include metals, acids and base neutral organics, volatile organics, pesticides and PCBs.

Non-conventional pollutants have been evaluated in this study because of their potential adverse impact when released into the environment as part of plant effluent, sludges or air

TABLE 6.4.6-1

WASTEWATER CHARACTERIZATION

| | DEER ISLAND | NUT ISLAND | COMBINED FLOWS | TYPICAL DOMESTIC WASTEWATER |
|---|---|---|---|---|
| BOD/COD | 0.67 | 0.73 | 0.69 | 0.40 - 0.70 |
| BOD/TSS | 1.15 | 0.95 | 1.08 | 1.00 |
| TVSS/TSS | 0.77 | 0.76 | 0.77 | 0.68 - 0.80 |
| BOD/TKN | 7.57 | 8.39 | 7.83 | 4.0 - 7.0 |
| BOD/P | 43.5 | 38.6 | 45.0 | 20.0 |
| BOD RATE COEFFICIENT - BASE 10 | 0.11 | 0.12 | ----- | 0.10 - 0.13 |
| $BOD_5 / BOD_u$ | 0.72 | 0.77 | ----- | 0.70 - 0.80 |

emissions.

Secondary treatment removes some, but not all, non-conventional pollutants from the wastewater. Therefore, a fraction of the non-conventional pollutants pass through the system and into the receiving water. The EPA has developed a series of water quality criteria known as the "Gold Book Criteria" which specify the acceptable levels of these constituents in receiving waters. The results of the following waste characterization studies will be used, along with studies of removal efficiencies and circulation, in the outfall siting studies to assess the potential impacts of the MWRA on compliance with the water quality criteria.

Some pollutants which are removed during the treatment processes become part of the residual from the plant. Residuals management options can be limited by the concentration of non-conventional pollutants. Both EPA and DEQE have regulations limiting the amounts of certain non-conventional pollutants allowed in conjunction with different residuals management options. These issues will be explored as part of the Residuals Management Facilities Plan.

The emission of volatile organics to the air during treatment must also be considered. EPA and DEQE have regulations to guide the evaluations of the emission of contaminants to the air. This topic is discussed in Section 8.3.15 Air Emissions Control of this volume.

In order to characterize the parameters described by these three sets of guidelines, sampling of the waste was conducted in the fall of 1986 and spring of 1987, including analyses of chemicals in the PPL and HSL directories. It should be noted that the study undertaken herein is a broad characterization of these pollutants and future detailed studies related to each specific guideline, e.g., Gold Book Criteria, will be conducted as required as part of the outfall siting or Residuals Management Facilities Plan.

In this report, non-conventional pollutants are reported in the same categories as defined in the PPL and HSL directives, namely, metals including cyanide, acid and base neutral (ABN) organics, pesticides and PCBs, and volatile organics (VOAs).

TABLE 6.5.1-1

Summary of Sampling Program

A wastewater sampling program was conducted during two seasons: fall of 1986 and spring of 1987. During 1986, samples were collected primarily at the headworks to Deer Island with some samples collected at Deer Island and at the Nut Island influent. During 1987, samples were collected at only the Deer Island and Nut Island influents. (For more information regarding the sampling program, refer to Appendix B of Volume III.) A summary of the results of the sampling program describing the number of samples and frequency of detection for metals, ABNs, pesticides and PCBs, and VOAs is shown in Tables 6.5.1-1 through 6.5.1-4 respectively. It should be noted that the large number of samples in the Fall program reflects the fact that the sampling was performed at each of four headworks rather than at the plant influent only.

The sampling program included collection at the headworks for Deer Island, at the Deer Island and Nut Island Influents, at the Nut Island and Deer Island effluents and some limited sludge sampling. However, for the purposes of characterizing current waste loads and predicting

TABLE 6.5.1-1

SUMMARY OF SAMPLING PROGRAM RESULTS
TOTAL METALS

| | Fall Program | | | | Spring Program | | | |
|---|---|---|---|---|---|---|---|---|
| | | Frequency of Detection | | | | Frequency of Detection | | |
| Constituent | Number of Samples | Number | Percent | Detection Limit (µg/L) (1) | Number of Samples | Number | Percent | Detection Limit (µg/L) (1) |
| Antimony | 40 | 0 | 0% | 25 | 16 | 3 | 19% | 2 |
| Arsenic | 40 | 0 | 0% | 10 | 19 | 13 | 68% | 1 |
| Beryllium | 40 | 0 | 0% | 20 | 16 | 0 | 0% | 1 |
| Boron | 40 | 5 | 13% | 200 | 16 | 16 | 100% | 50 |
| Cadmium | 40 | 1 | 3% | 5 | 19 | 12 | 63% | 1 |
| Chromium | 40 | 40 | 100% | 5 | 19 | 19 | 100% | 1 |
| Cooper | 40 | 38 | 95% | 50 | 19 | 19 | 100% | 1 |
| Cyanide, Total | 36 | 2 | 6% | 20 or 40 | 16 | 2 | 13% | 10 |
| Lead | 40 | 36 | 90% | 5 | 19 | 15 | 79% | 5 |
| Mercury | 40 | 8 | 20% | 1 | 16 | 12 | 75% | 0.5 |
| Molybdenum | 40 | 0 | 0% | 50 or 100 | 16 | 14 | 88% | 1 |
| Nickel | 40 | 16 | 40% | 20 | 19 | 19 | 100% | 2 |
| Selenium | 40 | 2 | 5% | 10 | 16 | 0 | 0% | 4 |
| Silver | 40 | 9 | 23% | 5 | 19 | 16 | 84% | 2 |
| Thallium | 40 | 0 | 0% | 10 | 16 | 0 | 0% | 2 |
| Zinc | 40 | 40 | 100% | 2 | 19 | 19 | 100% | 4 |

Not Detected - Metals

Beryllium
Thalliium
Hex. Chromium

Note:

(1) Detection limits were lowered for the Spring sampling program to reflect comparisons to EPA Water Quality Criteria.

## TABLE 6.5.1-2

## SUMMARY OF SAMPLING PROGRAM RESULTS
## TOTAL ACID AND BASE NEUTRALS

| | Fall Program | | | | Spring Progam | | | |
|---|---|---|---|---|---|---|---|---|
| | | Frequency of Detection | | | | Frequency of Detection | | |
| Constituent | Number of Samples | Number | Percent | Detection Limit Range (ug/L) | Number of Samples | Number | Percent | Detection Limit Range (ug/L) |
| Phenol | 21 | 15 | 71% | 20 - 28 | 6 | 1 | 17% | 20 - 27 |
| Benzyl alcohol | 21 | 13 | 62% | 20 - 28 | 6 | 0 | 0% | 20 - 27 |
| 1,2-Dichlorobenzene | 21 | 3 | 14% | 20 - 28 | 6 | 0 | 0% | 20 - 27 |
| 2-Methylphenol | 21 | 2 | 10% | 20 - 28 | 6 | 0 | 0% | 20 - 27 |
| 4-Methylphenol | 2 | 17 | 81% | 20 - 28 | 6 | 3 | 50% | 20 - 27 |
| Benzoic Acid | 21 | 16 | 76% | 100 - 140 | 6 | 1 | 17% | 100 - 130 |
| Naphthalene | 21 | 14 | 67% | 20 - 28 | 6 | 1 | 17% | 20 - 27 |
| 2-Methylnaphthalene | 21 | 16 | 76% | 20 - 28 | 6 | 1 | 17% | 20 - 27 |
| 2,4,5-Trichlorophenol | 21 | 1 | 5% | 100 - 140 | 6 | 0 | 0% | 100 - 130 |
| Dimethyl Phthalate | 21 | 1 | 5% | 20 - 28 | 6 | 1 | 17% | 20 - 27 |
| Diethyl Phthalate | 21 | 3 | 14% | 20 - 28 | 6 | 1 | 17% | 20 - 27 |
| N-Nitrosodiphenylamine (1) | 21 | 1 | 5% | 20 - 28 | 6 | 0 | 0% | 20 - 27 |
| Di-n-butyl Phthalate | 21 | 4 | 19% | 20 - 28 | 6 | 1 | 17% | 20 - 27 |
| Butylbenzyl Phthalate | 21 | 5 | 24% | 20 - 28 | 6 | 2 | 33% | 20 - 27 |
| Bis(2-ethylhexyl)Phthalate | 21 | 20 | 95% | 20 - 28 | 6 | 6 | 100% | 20 - 27 |
| Di-n-octyl Phthalate | 21 | 3 | 14% | 20 - 28 | 6 | 2 | 33% | 20 - 27 |

NOT DETECTED - Acid and Base Neutrals

| | | |
|---|---|---|
| Bis (2-Chloroethyl)ether | Hexachlorocyclopentadiene | Hexachlorobenzene |
| 2-Chlorophenol | 2,4,6-Trichlorophenol | Pentachlorophenol |
| 1,3-Dichlorobenzene | 2-Chloronapthalene | Phenanthrene |
| 1,4 Dichlorobenzene | 2-Nitroaniline | Anthracene |
| Bis(2-Chloroisopropyl)ether | Acenaphthene | Fluoranthene |
| N-Nitro-Dipropylamine | 3-Nitroaniline | Pyrene |
| Hexachloroethane | Acenaphthene | 3,3'-Dichlorobenzidine |
| Nitrobenzene | 2,4-Dinitrophenol | Benzo(a)anthracene |
| Isophorone | 4-Nitrophenol | Chrysene |
| 2-Nitrophenol | Dibenzofuran | Benzo(b)fluoranthene |
| 2,4-Dimethylphenol | 2,4-Dinitrotoluene | Benzo(k)fluoranthene |
| Bis(2-Chloroethoxy)methane | 2,6-Dinitrotoluene | Benzo(a)pyrene |
| 2,4-Dichlorophenol | 4-Chlorophenyl Phenyl Ether | Indeno(1,2,3-cd)pyrene |
| 1,2,4-Trichlorobenzene | Fluorene | Dibenz(a,h)anthracene |
| 4-Chloroaniline | 4-Nitroaniline | Benzo(g,h,i)perylene |
| Hexachlorobutadiene | 4,6-Dinitro-2-methylphenol | 1,2,3,4-Tetrachlorobenzene |
| 4-Chloro-3-methylphenol | 4-Bromophenol Phenyl Ether | |

## TABLE 6.5.1-3

## SUMMARY OF SAMPLING PROGRAM RESULTS

## TOTAL PESTICIDES AND PCBS

| | Fall Program | | | | Spring Progam | | | |
|---|---|---|---|---|---|---|---|---|
| | | Frequency of Detection | | | | Frequency of Detection | | |
| Constituent | Number of Samples | Number | Percent | Detection Limit Range (ug/L) | Number of Samples | Number | Percent | Detection Limit Range (ug/L) |
| ALPHA-BHC | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| BETA-BHC | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| DELTA-BHC | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| GAMMA-BHC | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| HEPTACHLOR | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| ALDRIN | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| HEPTACHLOR EPOXIDE | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| ENDOSULFAN I | 17 | 0 | 0% | 0.05 | 6 | 0 | 0% | 0.05 - 1 |
| DIELDRIN | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| | | | | | 6 | 0 | | |
| 4,4 -DDE | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| ENDRIN | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| ENDOSULFAN II | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| 4,4'-DDD | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| ENDOSULFAN SULFATE | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| 4,4'-DDT | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| ENDRIN KETONE | 17 | 0 | 0% | 0.10 | 6 | 0 | 0% | 0.10 - 2 |
| METHOXYCHLOR | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| CHLORDANE (TECHNICAL) | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| | | | | | 6 | 0 | | |
| TOXAPHENE | 17 | 0 | 0% | 1. | 6 | 0 | 0% | 1 - 2 |
| AROCLOR-1016 | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| AROCLOR-1221 | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| | | | | | 6 | 0 | | |
| AROCLOR-1232 | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| AROCLOR-1242 | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| AROCLOR-1248 | 17 | 0 | 0% | 0.50 | 6 | 0 | 0% | 0.50 - 10 |
| | | | | | 6 | 0 | | |
| AROCLOR-1254 | 17 | 0 | 0% | 1. | 6 | 0 | 0% | 1 - 20 |
| AROCLOR-1260 | 17 | 0 | 0% | 1. | 6 | 0 | 0% | 1 - 20 |

Note: All the Pesticides and PCBs that were tested for are listed above. None were detected.

## TABLE 6.5.1-4

## SUMMARY OF SAMPLING PROGRAM RESULTS

## TOTAL VOLATILES

| | Fall Program | | | | Spring Progam | | | |
|---|---|---|---|---|---|---|---|---|
| | | Frequency of Detection | | | | Frequency of Detection | | |
| Constituent | Number of Samples | Number | Percent | Detection Limit Range (ug/L) | Number of Samples | Number | Percent | Detection Limit Range (ug/L) |
| Bromomethane | 108 | 0 | 0% | 10 - 25 | 16 | 12 | 75% | 10 |
| Methylene Chloride | 108 | 44 | 41% | 12 - 12 | 16 | 16 | 100% | 5 |
| Acetone | 108 | 39 | 36% | 25 - 25 | 16 | 16 | 100% | 5 |
| Carbon Disulfide | 108 | 2 | 2% | 5 - 12 | 16 | 9 | 56% | 5 |
| trans-1,2-Dichloroethene | 108 | 19 | 18% | 5 - 12 | 16 | 13 | 81% | 5 |
| Chloroform | 108 | 23 | 21% | 5 | 16 | 16 | 100% | 5 |
| 2-Butanone | 108 | 4 | 4% | 10 - 25 | 16 | 14 | 88% | 5 |
| 1,1,1-Trichloroethane | 108 | 26 | 24% | 5 - 12 | 16 | 16 | 100% | 5 |
| Trichloroethene | 108 | 24 | 22% | 5 - 12 | 16 | 16 | 100% | 5 |
| Benzene | 108 | 16 | 15% | 5 | 16 | 16 | 100% | 5 |
| 4-Methyl-2-Pentanone | 108 | 2 | 2% | 10 - 25 | 16 | 0 | 0% | 10 |
| Tetrachloroethene | 108 | 36 | 33% | 5 - 12 | 16 | 16 | 100% | 5 |
| 1,1,2,2-Tetrachloroethane | 108 | 4 | 4% | 5 - 12 | 16 | 0 | 0% | 5 |
| Toluene | 108 | 76 | 70% | 5 | 16 | 16 | 100% | 5 |
| Chlorobenzene | 108 | 0 | 0% | 5 - 12 | 16 | 3 | 19% | 5 |
| Ethylbenzene | 108 | 18 | 17% | 5 - 12 | 16 | 14 | 88% | 5 |
| Styrene | 108 | 3 | 3% | 5 - 12 | 16 | 6 | 38% | 5 |
| Total Xylene; M, O, and P | 108 | 50 | 46% | 5 - 12 | 16 | 16 | 100% | 5 |

Not Detected VOLATILE COMPOUNDS

| | |
|---|---|
| Chloromethane | 1,2-Dichloropropane |
| Vinyl Chloride | trans-1,3-Dichloropropene |
| Chloroethane | Dibromochloromethane |
| 1,1-Dichloroethene | 1,1,2-Trichloroethane |
| 1,1-Dichloroethane | cis-1,3-Dichloropropene |
| 1,2-Dichloroethane | 2-Chloroethylvinylether |
| Carbon Tetrachloride | Bromoform |
| Vinyl Acetate | 2-Hexanone |
| Bromodichloromethane | |

future waste loads, only the influent values were considered.

To characterize the metals loads to the proposed treatment plant, influent samples were collected for six days in the fall and nine days in the spring. For ABNs, samples were collected for 6 days in the fall and three days in the spring. Pesticide and PCB samples were collected on five days in the fall and on three days in the spring while, for VOCs, eight Fall samples and three spring samples were collected.

The following sections discuss the actual results of the sampling programs and the predicted future loads.

Prediction Of Future Loads

In this document, the future wasteloads of non-conventional pollutants are estimated to be the same as the current wasteloads. In actuality, as a result of the industrial pretreatment program to be undertaken by the MWRA, future wasteloads will be lower than current loads. However, since the results of the pretreatment program cannot be predicted adequately at this time, the current loads are used here as a conservative estimate of future loads. It should be noted that increased future flows have been reflected in these estimates. An analysis will be performed as part of the Residuals Management Facilities Plan to determine the impact of lower sludge metals concentrations on sludge management options resulting from the pretreatment program.

### 6.5.2 METALS

The purpose of this section is to set forth conclusions regarding the characterization of metal loadings for the Nut Island and Deer Island treatment plants.

This section discusses the results of recent sampling programs for metals, the increase in metal loadings that are expected to result from increased wastewater flows, and the potential impact of increased capture of stormwater runoff through a combined sewer overflow control program.

The estimated average mass loading and associated standard deviations are shown for constituents which were detected at least once during either testing program. The average mass is the sum of the average of the total pounds of pollutant found at Nut and Deer Island. The total pounds of pollutant for each day is based on the concentration measured in each sample and flow readings that were recorded on the day of the sample. In a number of cases, the concentrations were reported from the laboratory as below the detection limit (BDL) of the test method. In these instances, the following procedure was followed:

- for spring samples (which generally had the lowest detection limits), the detection limit was used as the concentration.

- o for fall samples, the fall detection limit was used if the spring sampling indicated that the loading was at or above the fall detection limit since one could not be assured that the results would fall between the two detection limits or below the spring limit. If the spring sampling indicated that the concentration would have been below the fall detection limits, the sample was not used in the analysis.

A summary of the existing metal loadings is shown in Table 6.5.2-1. For three metals, beryllium, thallium and hexavalent chromium (spring samples only), concentrations were always below the detection limit. In these cases no average loading is presented.

Metal Loads in the Future

For the purpose of estimating future mass loading that results from increases in wastewater flows, the metal loads have been increased in the same ratio as the increase in wastewater flows. If it is assumed that wastewater (as distinguished from infiltration/inflow) will increase from an average annual flow of 208 mgd to 239 mgd in the future, then the total metal loading would increase by the same percentage (15 %) over the same period of time. This approach assumes that future wastewater characteristics will be very similar to current characteristics.

The only significant change in system operation that will affect metal loadings is the increased capture of combined sewer overflows. As new stormwater retention facilities are completed, combined sewer overflows will be reduced. This will increase the plant loadings for metals. Quantifying the increase in loadings that will result from CSO capture is a complex problem.

Estimates of metal loadings from the Fall Sampling Program are considered dry weather loads because sampling occurred during periods of dry weather. For this reason these loadings include all pollutants from domestic, commercial and industrial activities. Therefore, the increased loads resulting from CSO capture equals the loadings from stormwater runoff.

To estimate the quality of stormwater, runoff information from EPA's Nationwide Urban Runoff Program (NURP) was used. Stormwater runoff metals quality from the NURP is summarized in Table 6.5.2-1. The values selected as estimates of urban stormwater quality in the MWRA service area were not subject to any special statistical analyses, but were selected as being representative of the range of observed CSO values.

Mass loadings of pollutant metals resulting from CSO capture are based on the selected values presented in Table 6.5.2-2. The average annual return of stormwater runoff from CSO capture is estimated to be 20 MGD. This 20 MGD represents 100% capture of runoff on an annual basis. Where no NURP value was chosen for a pollutant, the estimated loadings were based on the percentage of increased CSO capture to existing flow (20/208 = 15%).

## TABLE 6.5.2-1

## EXISTING METAL LOADINGS
(lbs/day)

| Constituent | Average Load | Standard Deviation |
|---|---|---|
| Antimony | 10.8 | 2.3 |
| Arsenic | 6.0 | 1.9 |
| Boron | 1261.2 | 2443.4 |
| Cadmium | 7.1 | 2.7 |
| Chromium | 75.8 | 29.5 |
| Copper | 345.1 | 103.4 |
| Cyanide, Total | 53.9 | 13.9 |
| Lead | 49.9 | 21.8 |
| Mercury | 4.1 | 5.2 |
| Molybdenum | 17.1 | 10.4 |
| Nickel | 66.0 | 29.5 |
| Selenium | 35.2 | 33.2 |
| Silver | 15.5 | 3.8 |
| Zinc | 738.8 | 841.8 |

Note: Average Load represents the non-sotrm mean load at Deer Island plus the non-storm mean load at Nut Island. Loadings are based on influent values only, which are reported in Summary Memorandum FB20C, and are the result of sample collections at the headworks for Deer Island, and Deer and Nut Island Influents.

## TABLE 6.5.2-2

## RUNOFF QUALITY - METALS
(ug/L)

| Constituent | Frequency of Detection (1) | Range of Observed Values (1) | Estimated Range of Mean Values (1) | Selected Value (2) |
|---|---|---|---|---|
| Antimony | 13% | 2.6-23 | | 23.0 |
| Arsenic | 52% | 1-50 | 1.6-4.3 | 4.3 |
| Boron | Not Done | | | NA |
| Cadmium | 48% | 1-14 | .6-1.6 | 1.6 |
| Chromium | 58% | 1-190 | 3.1-8.5 | 8.5 |
| Copper | 91% | 1-100 | 17.9-19.5 | 19.5 |
| Cyanide, Total | 23% | 2-300 | | 300.0 |
| Lead | 94% | 6-460 | 65.6-72.8 | 72.8 |
| Mercury | 9% | 0.6-1.2 | | 1.2 |
| Molybdenum | Not Done | | | NA |
| Nickel | 43% | 1-182 | 5.8-19.1 | 19.1 |
| Selenium | 11% | 2-77 | | 77.0 |
| Silver | 7% | 0.2-0.8 | | 0.8 |
| Zinc | 94% | 10-2400 | 92.3-103.7 | 103.7 |

Notes: (1) The data is taken from the EPA's National Urban Runoff Program Study.
(2) The selected value is the upper confidence interval of the geometric mean of pollutants detected more than 20% of the time, or the maximum observed value, where a estimated mean value does not exist.

Summary of Future Metal Loads

Aggregate future metal loads were computed based on an existing load, and increases from new wastewater and capture of urban runoff. The results of these computations are shown in Table 6.5.2-3. These are annual average loadings, and are subject to day-to-day variability.

## 6.5.3 ACID BASE NEUTRALS

This section describes the characterization of acid and base-neutral (ABN) loadings for the Nut Island and Deer Island Treatment Plants. The ABN terminology arises from the analytical methods used to quantify these organic compounds. The methods use either an acid or base-neutral extraction in the procedure. In the aggregate, there are 66 organic chemicals classified under the PPL and HSL, which comprise the ABN fractions.

Fall and Spring Sampling Program Results

Estimates of the existing average mass and standard deviations of the detected ABN compounds are shown on Table 6.5.3-1. As was done with the metals fractions, the average mass is based on the observed flows on the day of sampling, as well as the observed concentrations, while test results which were below the analytical detection limit were replaced with the detection limit.

ABN Loads in the Future

Increases in future loadings of the ABN fraction were also computed in a manner comparable to that used for metals. Increases in future loadings attributable to increases in wastewater flow (as distinguished from infiltration and inflow) were taken as the prorata increase in flow.

Increases in loadings of ABNs associated with improved CSO management practices have been estimated based on the estimated average runoff volume of 50 mgd and concentrations of ABNs in urban runoff. Data from EPA's NURP Program were used to select a value for runoff quality for those compounds which were detected in the wastewater sampling. Information concerning the compounds, their frequencies of detection and ranges of concentrations are presented in Table 6.5.3-2.

For the purpose of estimating runoff loads, the highest observed values were used. If the constituent was not analyzed as part of the NURP program, the existing load was incremented by the ratio of the projected runoff flow to the wastewater flow.

Summary of Future ABN Loads

Aggregate future ABN loadings were computed based on the existing loads, increases from new wastewater generated in the service area, and capture of urban runoff. The results of these

## TABLE 6.5.2-3

## FUTURE METAL LOADINGS
## (lbs/day)

| Constituent | Existing Average mass Loadings | Flow Related Increase (1) | Projected Non-Runoff Average Mass Loadings (2) | Runoff Loadings Increase (3) | Projected Total Average Mass Loadings (4) |
|---|---|---|---|---|---|
| Antimony | 10.8 | 1.6 | 12.4 | 3.8 | 16.2 |
| Arsenic | 6.0 | 0.9 | 6.9 | 0.7 | 7.6 |
| Boron | 1261.2 | 188.0 | 1449.2 | 121.3 | 1570.5 |
| Cadmium | 7.1 | 1.1 | 8.2 | 0.3 | 8.4 |
| Chromium | 75.8 | 11.3 | 87.1 | 1.4 | 88.5 |
| Copper | 345.1 | 51.4 | 396.5 | 3.3 | 399.8 |
| Cyanide, Total | 53.9 | 8.0 | 61.9 | 50.0 | 112.0 |
| Lead | 49.9 | 7.4 | 57.3 | 12.1 | 69.5 |
| Mercury | 4.1 | 0.6 | 4.8 | 0.2 | 5.0 |
| Molybdenum | 17.1 | 2.6 | 19.7 | 1.6 | 21.3 |
| Nickel | 66.0 | 9.8 | 75.9 | 3.2 | 79.1 |
| Selenium | 35.2 | 5.2 | 40.4 | 12.8 | 53.3 |
| Silver | 15.5 | 2.3 | 17.8 | 0.1 | 18.0 |
| Zinc | 738.8 | 110.1 | 848.9 | 17.3 | 866.2 |

Notes: (1) Wastewater incremented in proportion to increases in wastewater discharges. Average daily flow is projected to increase from 208 MGD to 239 MGD.

(2) The Projected Non-Runoff Average Mass Loading is the sum of the Existing Average Mass Loading and the Flow Related Increase.

(3) The Increase from the Runoff Loading is based on either the:
a) avg. daily runoff return flow equal to 20 MGD and concentrations taken from the "Selected" column of TABLE 6.5.2-2, or

b) avg. daily runoff return flow equal to 20 MGD and concentrations taken from the existing average mass loading with flow equal to 208 MGD.

(4) The projected Total Average Mass Loading is the sum of the Projected Non-Runoff Average Mass Loading and the Runoff Loadings Increase.

## TABLE 6.5.3-1

## EXISTING ABN LOADINGS
(lbs/day)

| Constituent | Average Load | Standard Deviation |
|---|---|---|
| Phenol | 54.0 | 27.1 |
| Benzyl Alcohol | 69.3 | 24.7 |
| 1, 2-Dichlorobenzene | 65.1 | 23.3 |
| 2-Methylphenol | 71.0 | 18.3 |
| 4-Methylphenol | 61.2 | 23.2 |
| Benzoic Acid | 269.4 | 138.9 |
| Naphthalene | 45.3 | 28.4 |
| 2-Methylnaphthalene | 49.6 | 26.7 |
| 2, 4, 5-Trichlorophenol | 349.0 | 95.8 |
| Dimethyl Phthalate | 69.6 | 19.4 |
| Diethyl Phthalate | 57.1 | 24.5 |
| N-Nitrosodiphenylamine (1) | 69.3 | 19.7 |
| Di-n-butyl Phthalate | 57.9 | 25.9 |
| Butylbenzyl Phthalate | 54.0 | 24.1 |
| Bis (2-ethylhexyl) Phthalate | 67.8 | 20.0 |
| Di-n-octyl Phthalate | 57.0 | 21.4 |

Note: Average Load represents the non-storm mean load at Deer Island plus the non-storm mean load at Nut Island. Loadings are based on influent values only, which are reported in Summary Memorandum FB20C, and are the result of sample collections at the headworks for Deer Island and Deer and Nut Island Influents.

## TABLE 6.5.3-2

## RUNOFF QUALITY - ABNS
(µg/L)

| Constituent | Frequency Of Detection | Range of Values | Selected Value |
|---|---|---|---|
| Phenol | 14% | 1 - 13 | 13.0 |
| Benzyl Alcohol | Not Done | NA | NA |
| 1,2-Dichlorobenzene | 0% | 0 | 0.0 |
| 2-Methylphenol | Not Done | NA | NA |
| 4-Methylphenol | Not Done | NA | NA |
| Benzoic Acid | Not Done | NA | NA |
| Naphthalene | 9% | 0.8 - 2.3 | 2.3 |
| 2-Methylnaphthalene | Not Done | NA | NA |
| 2,4,5-Trichlorophenol | Not Detected | 0 | 0.0 |
| Dimethyl Phthalate | 1% | 1 | 1.0 |
| Diethyl Phthalate | 6% | 1 - 10 | 10.0 |
| N-Nitrosodiphenylamine (1) | Not Done | NA | NA |
| Di-n-butyl Phthalate | 6% | 0.5 - 11 | 11.0 |
| Butylbenzyl Phthalate | 6% | 1 - 10 | 10.0 |
| Bis(2-ethylhexyl)Phthalate | 22% | 0.4 - 2 | 2.0 |
| Di-n-octyl Phthalate | 6% | 0.5 - 2 | 2.0 |

computations are shown in Table 6.5.3.-3. These are subject to day-to-day variability.

## 6.5.4 PESTICIDES AND PCBs

### Fall and Spring Sampling Program Results

Since no pesticides or PCBs were found in this sampling, specific projects may have to be implemented to investigate these compounds further.

These should include an evaluation of sludge in conjunction with wastewater sampling. Interpolation of PCBs and pesticides in the sludge to a projected influent can be made. However, at this time sufficient data is not available to calculate these values.

## 6.5.5 VOLATILE ORGANIC COMPOUNDS

Unlike the other constituents, where composite samples were always taken from the influent to the Nut and Deer Island plants, the volatile sampling differed in the following respects:

- The analytical protocols require that grab samples be used. In this program, grab samples were taken every six hours.

- During the Fall program, samples of the Deer Island influent were not taken. Rather, samples were taken at each of the four headworks. The results of these were combined to produce an estimate of the Deer Island load.

### Fall and Spring Sampling Program Results

Estimates of the existing average mass and standard deviations of the detected volatile compounds are shown on Table 6.5.5-1. As was done with the metals fractions, the average mass is based on the observed flows and observed concentrations at the time of sampling, while test results which were below the analytical detection limit were replaced with the detection limit.

### Volatile Organics Loads in the Future

Increases in future loadings of the volatile fraction were also computed in a manner comparable to that used for metals and ABNs. Increases in loadings of volatiles associated with improved CSO management practices have been estimated based on the estimated average runoff volume of 50 mgd and the concentrations of volatiles in urban runoff. Data from EPA's NURP Program were used to select a value for runoff quality for those compounds which were detected in the wastewater sampling. Information concerning the compounds, their frequencies of detection, and ranges of concentrations are presented in Table 6.5.5-2. For the purpose of estimating runoff loads, the highest observed values were used. If the constituent was not analyzed as part of the NURP program, the existing load was incremented by the ratio of the projected runoff flow to the wastewater flow.

## TABLE 6.5.3-3

## FUTURE ABN LOADINGS
## (lbs/day)

| Constituent | Existing Average mass Loadings | Flow Related Increase (1) | Projected Non-Runoff Average Mass Loadings (2) | Runoff Loadings Increase (3) | Projected Total Average Mass Loadings (4) |
|---|---|---|---|---|---|
| Phenol | 54.0 | 8.0 | 62.1 | 2.2 | 64.2 |
| Benzyl Alcohol | 69.3 | 10.3 | 79.7 | 6.7 | 86.3 |
| 1,2-Dichlorobenzene | 65.1 | 9.7 | 74.8 | 0.0 | 74.8 |
| 2-Methylphenol | 71.0 | 10.6 | 81.5 | 6.8 | 88.4 |
| 4-Methylphenol | 61.2 | 9.1 | 70.4 | 5.9 | 76.3 |
| Benzoic Acid | 269.4 | 40.2 | 309.6 | 25.9 | 335.5 |
| Napthalene | 45.3 | 6.8 | 52.1 | 0.4 | 52.5 |
| 2-Methylnaphthalene | 49.6 | 7.4 | 57.0 | 4.8 | 61.8 |
| 2,4,5-Trichlorophenol | 349.0 | 52.0 | 401.0 | 0.0 | 401.0 |
| Dimethyl Phthalate | 69.6 | 10.4 | 80.0 | 0.2 | 80.2 |
| Diethyl Phthalate | 57.1 | 8.5 | 65.6 | 1.7 | 67.3 |
| N-Nitrosodiphenylamine (1) | 69.3 | 10.3 | 79.6 | 6.7 | 86.3 |
| Di-n-butyl Phthalate | 57.9 | 8.6 | 66.5 | 1.8 | 68.4 |
| Butylbenzyl Phthalate | 54.0 | 8.0 | 62.0 | 1.7 | 63.7 |
| Bis(2-ethylhexyl)Phthalate | 67.8 | 10.1 | 77.9 | 0.3 | 78.3 |
| Di-n-octyl Phthalate | 57.0 | 8.5 | 65.5 | 0.3 | 65.8 |

Notes: (1) Wastewater incremented in proportion to increases in wastewater discharges. Average daily flow is projected to increase from 208 MGD to 239 MGD.

(2) The Project Non-Runoff Average Mass Loading is the sumof the Existing Average Mass Loading and the Flow Related Increase.

(3) Storm flow loads are based on either the:
a) avg. daily runoff return flow equal to 30 MGD and concentrations taken from the "Selected" column of TABLE 6.5.3-2

b) avg. daily runoff return flow equal to 20 MGD and concentrations taken from the existing average mass loading with flow equal to 208 MGD

(4) The Projected Total Average Mass Loading is the sum of the Projected Non-Runoff Average Mass Loadings and the Runoff Loadings Increase.

TABLE 6.5.5-1

EXISTING VOLATILE LOADINGS
(lbs/day)

| Constituent | Average Load | Standard Deviation |
|---|---|---|
| Bromomethane | 54.3 | 19.3 |
| Methylene Chloride | 104.7 | 75.3 |
| Acetone | 337.1 | 268.6 |
| Carbon Disulfide | 27.5 | 7.6 |
| trans-1,2-Dichloroethene | 25.6 | 7.8 |
| Chloroform | 17.6 | 8.1 |
| 2-Butanone | 82.5 | 43.8 |
| 1,1,1-Trichloroethane | 41.8 | 17.9 |
| Trichloroethene | 36.2 | 19.2 |
| Benzene | 12.5 | 2.3 |
| 4-Methyl-2-Pentanone | 64.7 | 23.7 |
| Tetrachloroethene | 47.4 | 27.8 |
| 1,1,2,2-Tetrachloroethane | 29.4 | 6.4 |
| Toluene | 60.8 | 38.1 |
| Chlorobenzene | 28.0 | 7.6 |
| Ethylbenzene | 28.8 | 13.0 |
| Styrene | 30.1 | 7.3 |
| Total Xylene; M, O, and P | 85.9 | 59.4 |

Note: Average Load represents the non-storm mean load at Deer Island plus the non-storm mean load at Nut Island. Loadings are based on influent values only, which are reported in Summary Memorandum FB20C, and are the result of sample collections at the headworks for Deer Island and Deer and Nut Island Influents.

## TABLE 6.5.5-2

## RUNOFF QUALITY - VOLATILES

| Constituent | Frequency Of Detection | Range of Values (µg/L) | Selected Value (µg/L) |
|---|---|---|---|
| Bromomethane | Not Detected | 0 | 0.0 |
| Methylene Chloride | Not Detected | 0 | 0.0 |
| Acetone | Not Done | NA | NA |
| Carbon Disulfide | Not Done | NA | NA |
| trans-1,2-Dichloroethene | 4% | 1 - 3 | 3.0 |
| Chloroform | 9% | 0.2 - 12 | 12.0 |
| 2-Butanone | Not Done | NA | NA |
| 1,1,1-Trichloroethane | 6% | 1.6 - 10 | 10.0 |
| Trichloroethene | 6% | 0.3 - 12 | 12.0 |
| Benzene | 5% | 1 - 13 | 13.0 |
| 4-Methyl-2-Pentanone | Not Done | NA | NA |
| Tetrachloroethene | 5% | 1 - 43 | 43.0 |
| 1,1,2,2-Tetrachloroethane | 4% | 2 - 3 | 3.0 |
| Toluene | 3% | 3 - 9 | 9.0 |
| Chlorobenzene | 5% | 1 - 10 | 10.0 |
| Ethylblenzene | 6% | 1 - 2 | 2.0 |
| Styrene | Not Done | NA | NA |
| Total Xylene; M, O, and P | Note Done | NA | NA |

Summary of Future Volatile Loads

Aggregate future volatile loadings were computed based on the existing loads, increases from new wastewater generated in the service area, and capture of urban runoff. The results of these computations are shown in Table 6.5.5-3. These are subject to day-to-day variability.

## 6.6 SUMMARY

This section on flows and loads has reached the following conclusions:

- The connected population of the Authority's sewer service area will increase from the present estimate of approximately 1.9 million to 2.1 million in the design year 2020. This will result in an increase of about 13 million gallons per day (mgd) of domestic wastewater flow over the current level of 123 mgd.

- Through the year 2020, wastewater discharges which result from the business activity within the service area will increase by approximately 14 mgd, from 46 mgd at present to 60 mgd in the year 2020. The increase is due entirely to increases in wastewater flows from service-oriented business. The total volume of wastewaters discharged by large users is expected to remain relatively constant at 43 mgd over the period. Total nondomestic wastewater discharges are expected to average 103 mgd in the design year.

- Total domestic and nondomestic wastewater flows will average about 239 mgd by the year 2020.

- Rainfall-induced flows, both infiltration/inflow (I/I) and combined sewage flows, will continue to represent a large fraction of the volume of wastewater received at the plant. Average I/I is expected to vary from approximately 150 mgd to 430 mgd, depending on time of the year and groundwater levels. While significant, the I/I allowances are based on substantial reductions from existing maximum I/I amounts and require the implementation of various correction programs now being studied by the Authority and the Commonwealth.

- The total flow to be accommodated from MWRA's South System service area is 360 mgd. This flow is the hydraulic capacity, without surcharging, of the South System's major interceptor, the High Level Sewer.

- Annual nonstorm flow to the plant by the year 2020 is expected to average approximately 480 mgd, based on average flow of 390 mgd during low groundwater conditions and 670 mgd during high groundwater conditions. Low groundwater conditions are generally defined as the period from late spring through early winter. High groundwater conditions occur generally during the late winter - early spring period.

## TABLE 6.5.5-3

## FUTURE VOLATILE LOADINGS
## (lbs/day)

| Constituent | Existing Average mass Loadings | Flow Related Increase (1) | Projected Non-Runoff Average Mass Loadings (2) | Runoff Loadings Increase (3) | Projected Total Average Mass Loadings (4) |
|---|---|---|---|---|---|
| Bromomethane | 54.3 | 8.1 | 62.3 | 0.0 | 62.3 |
| Methylene Chloride | 104.7 | 15.6 | 120.3 | 0.0 | 120.3 |
| Acetone | 337.1 | 50.2 | 387.3 | 32.4 | 419.7 |
| Carbon Disulfide | 27.5 | 4.1 | 31.6 | 2.6 | 34.3 |
| trans-1,2-Dichloroethene | 25.6 | 3.8 | 29.4 | 0.5 | 29.9 |
| Chloroform | 17.6 | 2.6 | 20.3 | 2.0 | 22.3 |
| 2-Butanone | 82.5 | 12.3 | 94.8 | 7.9 | 102.8 |
| 1,1,1-Trichloroethane | 41.8 | 6.2 | 48.0 | 1.7 | 49.7 |
| Trichloroethene | 36.2 | 5.4 | 41.6 | 2.0 | 43.6 |
| Benzene | 12.5 | 1.9 | 14.3 | 2.2 | 16.5 |
| 4-Methyl-2-Pentanone | 64.7 | 9.6 | 74.3 | 6.2 | 80.5 |
| Tetrachloroethene | 47.4 | 7.1 | 54.5 | 7.2 | 61.7 |
| 1,1,2,2-Tetrachloroethane | 29.4 | 4.4 | 33.8 | 0.5 | 34.3 |
| Toluene | 60.8 | 9.1 | 69.8 | 1.5 | 71.3 |
| Chlorobenzene | 28.0 | 4.2 | 32.1 | 1.7 | 33.8 |
| Ethylbenzene | 28.8 | 4.3 | 33.1 | 0.3 | 33.4 |
| Styrene | 30.1 | 4.5 | 34.6 | 2.9 | 37.5 |
| Total Xylene; M, O, and P | 85.9 | 12.8 | 98.7 | 8.3 | 107.0 |

Notes: (1) Wastewater incremented in proportion to increases in wastewater discharges. Average daily flow is projected to increase from 208 MGD to 239 MGD.

(2) The Projected Non-Runoff Average Mass Loading is the sum of the Existing Average Mass Loading and the Flow Related Increase.

(3) Storm flow loads are based on either the:

a) avg. daily runoff return flow equal to 20 MGD and concentrations taken from the "Selected" column of TABLE 6.5.5-2, or

b) avg. daily runoff return flow equal to 20 MGD and concentrations taken from the existing average mass loading with flow equal to 208 MGD.

(4) The projected Total Average Mass Loading is the sum of the Projected Non-Runoff AVerage Mass Loading and the Runoff Loadings Increase.

- On the average day, the capacity of the plant to accept stormwater, either directly or as CSO return flows, will vary from about 600 to 880 mgd depending on the time of the year.

- A sensitivity analysis of flows was performed which indicated that the total flows are most sensitive to the volume of infiltration/inflow entering the system. System management can be structured to compensate for any unanticipated increase in domestic or nondomestic wastewater flow, through reductions in infiltration/inflow.

- Average daily nonstorm loadings of total suspended solids and biochemical oxygen demand are expected to increase about 12 percent to 570,000 lbs/day of BOD and 515,000 lbs/day of TSS over the planning period. These increased loadings are attributable to increases in wastewater flow. Maximum daily BOD and TSS loadings are expected to be 2.0 and 2.1 times the average, respectively. During storm conditions additional loadings will reach the plant. The total suspended solids loading rate from stormwater will increase the wastewater loadings by approximately 400,000 lbs/day. The biochemical oxygen demand loading rate from stormwater will increase the wastewater loadings by approximately 165,000 lbs/day.

- Nonconventional pollutant loadings (metals, acids and base neutral organics, volatile organics, pesticides and PCBs) to Deer Island will increase in the future in proportion to the increase in future wastewater flow to the plant (approximately 15 percent) and the degree to which combined sewer overflows are captured. For selected nonconventional pollutants the CSO increase ranges from a few percent to up to 25 percent compared to existing loadings, assuming that all CSOs are captured and returned to the plant.

A summary of the projected flows (rounded to the nearest 10 mgd) and loadings is presented in Table 6.6-1. Figure 6.6-1 summarizes the design year flow, by components, for low and high groundwater conditions.

## TABLE 6.6-1

## SUMMARY OF DESIGN YEAR (2020) FLOWS AND LOADING

| | Low Groundwater Conditions | | High Groundwater Conditions | |
|---|---|---|---|---|
| | Average Day | Maximum Day | Average Day | Maximum Day |
| Non-Storm Conditions | | | | |
| Total Wastewater (mgd) | 390 | 600 | 670 | 950 |
| BOD (1000 lb/day) | 570 | 1140 | 570 | 1140 |
| TSS (1000 lb/day) | 515 | 1080 | 515 | 1080 |
| Storm Conditions | | | | |
| Total Wastewater (mgd) | --- | 600 | --- | 950 |
| Stormwater (mgd) | --- | 550 | --- | 320 |
| Total (mgd) | --- | 1150 | --- | 1270 |
| BOD (1000 lb/day) | --- | 1305 | --- | 1305 |
| TSS (1000 lb/day) | --- | 1480 | --- | 1480 |

(Annual Average Flow is 480 mgd based on 4 months of high groundwater conditions and 8 months of low groundwater conditions)

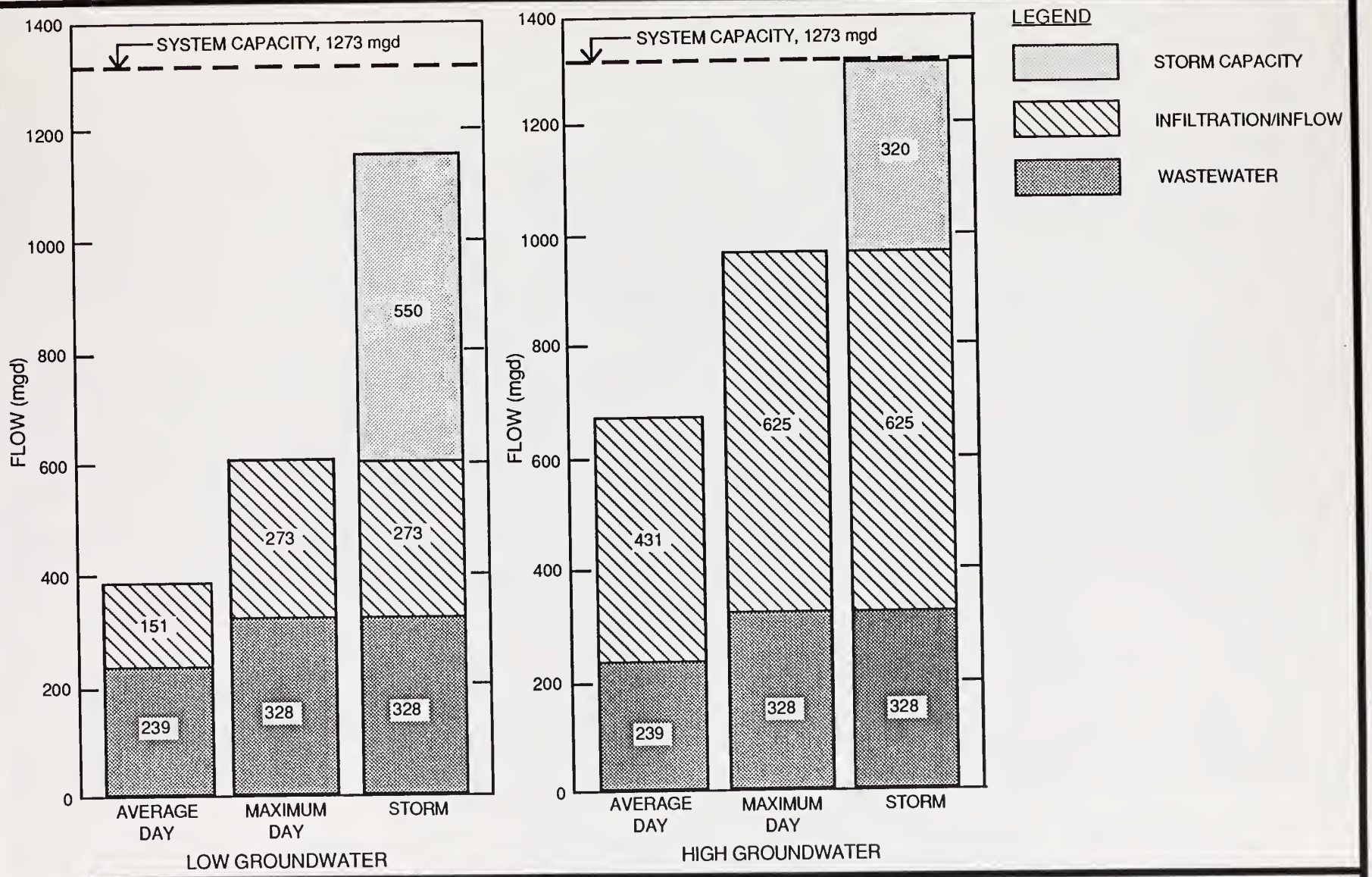



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**FIGURE 6.6-1**
**SUMMARY OF DESIGN YEAR FLOWS**

# Section 7

# 7.0 PLANT PERFORMANCE

## 7.1 INTRODUCTION

This section addresses the expected removal efficiency, and projects effluent quality, for the proposed treatment facilities on Deer Island. The expected effluent quality is discussed in terms of both the primary and secondary components of the proposed facilities.

Removal efficiencies impact the effluent quality and the characteristics of the residuals. Projected effluent quality in turn impacts the assessment of the plant discharge upon the receiving waters and, consequently, the location of the outfall terminus. The removal efficiencies of various processes are subgrouped into two broad categories: conventional pollutants and non-conventional pollutants. Conventional pollutants are defined as Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), which are conventionally used to define the level of wastewater treatment. The definition of non-conventional pollutants includes Priority Pollutants and Hazardous Substance List compounds which have been identified as present in the MWRA wastewaters. These compounds include heavy metals and volatile organics.

Required or desired removal efficiencies establish the degree of treatment required (primary, secondary, or advanced). Desired removal efficiencies of the conventional parameters establish the sizing of primary and secondary treatment units and equipment provided. Thus, the costs and area requirements for a primary and secondary treatment plant are directly related to the required degree of removal of the BOD and TSS present in the raw wastewaters. Removal of the non-conventional pollutants is not as directly affected. Once a degree of primary and secondary treatment is established, removals of the non-conventional pollutants can be estimated, but are essentially equal for all alternatives providing the same degree of treatment. Levels of removal of the non-conventional pollutants are not necessarily controllable in primary and secondary treatment units. Specific removal of various non-conventional pollutants can only be achieved or controlled through advanced levels of wastewater treatment.

Projected treatment efficiencies for both conventional and non-conventional parameters are presented in this section. The removal efficiencies for the conventional parameters are based upon required treatment objectives. The removal efficiencies for the non-conventional parameters are estimated removal rates based upon the level of treatment provided for the required removal of the conventional parameters. If outfall or residuals related aspects of the program require reduced impacts due to non-conventional pollutants, increased dilution at the outfall terminus or increased levels of source control through the industrial pretreatment program will have to be provided.

## 7.2 FLOW CONDITIONS

The performance of the Deer Island treatment plant has been estimated under the three distinctive flow conditions: seasonal high groundwater conditions, seasonal low groundwater conditions, and storm conditions which can occur at any time of the year.

Design flow and loadings are presented in Section 6.2. The average annual flow is estimated to be 480 mgd. During non-storm conditions, under high groundwater conditions, the peak hour flow to the plant is estimated to be 1000 mgd. Under storm conditions peak flows are 1270 mgd based on the hydraulic limitations of the transmission system.

## 7.3 CONVENTIONAL POLLUTANTS

### 7.3.1 REMOVAL REQUIREMENTS

The required removal efficiency of the conventional pollutants is defined by discharge permit limitations. The NPDES permit established the following limitations for BOD and TSS:

Average Monthly: 30 mg/l
Average Weekly: 45 mg/l
Maximum Daily : 50 mg/l

In addition, the permit requires the Deer Island Plant to maintain a minimum of 85 percent removal of both TSS and BOD based on monthly average values.

### 7.3.2 PERFORMANCE REMOVAL

Removals of BOD and TSS in the primary portion of the treatment plant were estimated using published removal efficiency curves for domestic wastewater. Removals at the existing MWRA plants, for existing loading rates, have demonstrated the applicability of these curves. Projected primary plant effluent for the conventional parameters BOD and TSS in the year 1999, prior to operation of the secondary treatment facility, are presented in Table 7.3.2-1. Removal rates for estimating these values are presented in Figure 7.3.2-1.

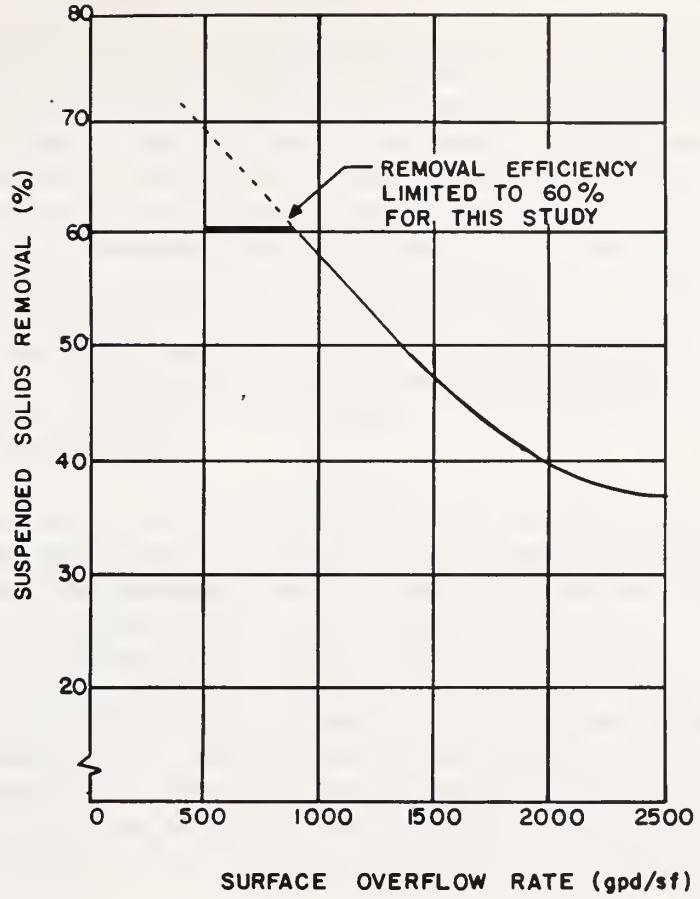
Statistical analyses of operating secondary treatment plants have shown that in order to continuously meet the monthly criteria of 30 mg/l BOD and TSS, plants must produce an annual average effluent of about 15 mg/l BOD and TSS. The Deer Island treatment plant is being sized for this level of performance. A plant sized for this level of treatment can be expected to produce a maximum daily secondary effluent of 40 mg/l BOD and TSS, which is significantly less than the daily limits required in the draft NPDES permit. This margin compelled a design strategy which satisfies permit requirements by providing primary treatment for all flow and providing secondary treatment for some rate of flow greater than peak dry weather flow, yet not equal to full hydraulic capacity.

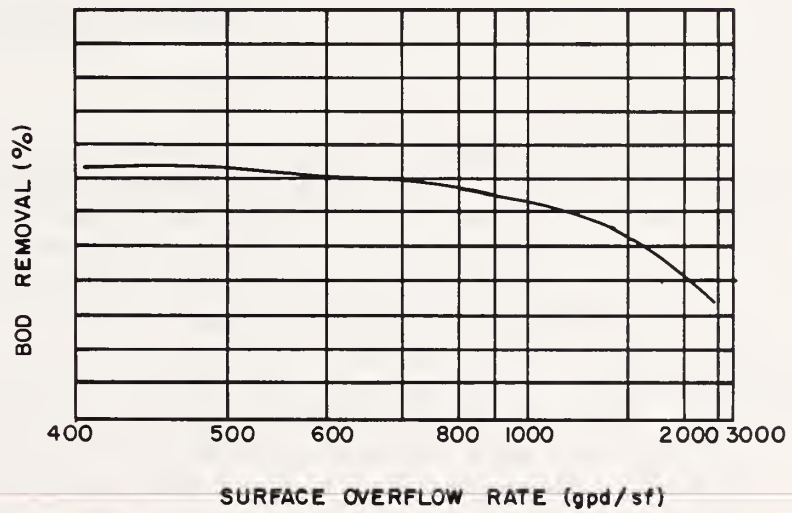
The secondary portion of the treatment plant has been sized to treat up to a rate of 1080 mgd. Flow in excess of this, up to the plant capacity of 1270 mgd, would receive primary treatment and be mixed, after screening to remove flotables, with the secondary effluent for disinfection and discharge to the outfall. Under peak loading conditions equivalent to maximum day with storm, the primary portion of the treatment plant, operating at an overflow rate of 2000 gpd/sf, is expected to produce an effluent containing no more than 87 mg/l TSS and 101 mg/l BOD. The effluents produced by mixing various quantities of this primary effluent with a 40 mg/l secondary effluent are shown in Figure 7.3.2-2. In order to meet the 50 mg/l maximum

## TABLE 7.3.2-1

## PROJECTED PRIMARY EFFLUENT
## CONVENTIONAL POLLUTANTS
## YEAR 1999

| | Low Groundwater | | | High Groundwater | | |
|---|---|---|---|---|---|---|
| | Average Day | Maximum Day | Storm | Average Day | Maximum Day | Storm |
| **Primary Effluent** | | | | | | |
| Flow - mgd | 377 | 592 | 1,150 | 657 | 947 | 1,270 |
| **TSS** | | | | | | |
| lb/day | 211,000 | 428,000 | 838,000 | 222,000 | 556,000 | 882,000 |
| mg/L | 67 | 87 | 87 | 44 | 70 | 83 |
| % Removed | 60 | 60 | 43 | 58 | 48 | 40 |
| **BOD** | | | | | | |
| lb/day | 380,000 | 782,000 | 1,013,000 | 410,000 | 840,000 | 1,026,000 |
| mg/L | 121 | 158 | 106 | 75 | 106 | 97 |
| % Removed | 36 | 32 | 23 | 31 | 27 | 22 |




SOURCE: CLARIFIER DESIGN, MANUAL OF PRACTICE FD-8, WPCF, 1985

| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 7.3.2-1<br>SUSPENDED SOLIDS AND BOD REMOVAL IN PRIMARY CLARIFIERS |
|---|---|

daily limit of BOD and TSS at least 1064 mgd of the total plant flow of 1270 would have to receive secondary treatment. To produce a higher quality effluent under maximum flow conditions, one of the four primary treatment batteries will be limited to an overflow rate of 1200 gpd/sf, which will result in a primary effluent from this battery containing 69 mg/l TSS and 91 mg/l BOD. The maximum flow achievable through one primary battery at 1200 gpd/sf is 190 mgd. To ensure that only effluent from this primary battery will be discharged directly to disinfection for mixture with the secondary effluent, the secondary plant has been sized at 1080 mgd. This approach has been taken to avoid hydraulically overloading the secondary plant, thus degrading effluent quality, and to keep overall plant space requirements as small as possible while still providing facilities capable of meeting the required discharge limits. This operating procedure is expected to produce a storm-related maximum daily effluent of 44 mg/l TSS and 48 mg/l BOD. Maximum week requirements can be met under these conditions with up to four days of storm impacts per week.

Projected primary and secondary effluents for the conventional parameters BOD and TSS in the design year 2020 are presented in Tables 7.3.2-2 and 7.3.2-3. The projected plant effluent is within the required concentration limitations of the NPDES permit. However, the 85 percent removal requirement of the proposed permit cannot be met under all circumstances. During high groundwater conditions, the increased infiltration/inflow results in the dilution of the incoming wastewater to an average of about 102 mg/l BOD and 92 mg/l SS. The projected percent removals during an average day are estimated to be about 77 percent for TSS and 79 percent for BOD. These lower removal rates are the result of weak influent concentrations and not the result of decreased process efficiency. Higher levels are not achievable without going beyond secondary treatment. The 85 percent removal requirement should be modified to reflect the dilute wastewater concentration as has been done under similar conditions for other treatment facilities.

## 7.4 NONCONVENTIONAL POLLUTANTS

### 7.4.1 METALS

Estimates of the mass of metals in the influent wastewater were based on the Fall 1986 and Spring 1987 sampling programs, as presented in Section 6.2. Projected primary and secondary effluent mass loading of the fourteen metals detected in the raw wastewater are presented in Table 7.4.1-1. Removal efficiencies for primary and secondary treatment were based on EPA reports, data from the Seattle and Los Angeles County wastewater treatment plants and discussions with the Residuals Solids Management Facilities Plan consultant Black & Veatch. The two primary EPA sources used were the report on Fate of Priority Pollutants in Publicly Owned Treatment Works, Vol. I, (EPA 440/1-82/303) and Appendix O of the Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works (EPA/530-SW-86-004). The removal efficiency was assumed equal under all flow conditions. Primary effluent in the year 1999 has been assumed to be equal to the design year primary effluent shown in Table 7.4.1-1 because the influent wastewater flow will increase by only a few percent during the planning period.

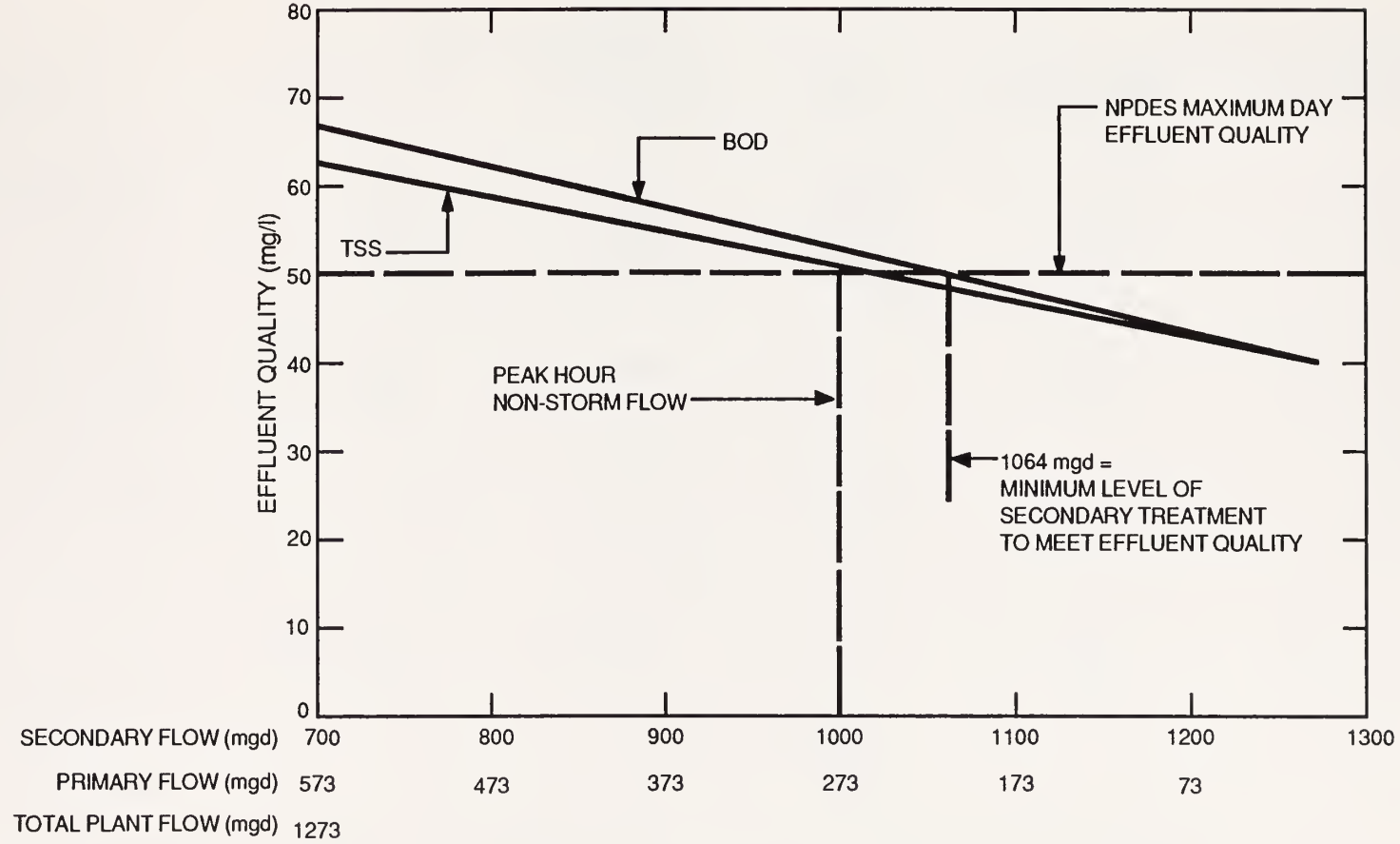



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**FIGURE 7.3.2-2**
**PLANT DISCHARGE MAXIMUM DAY - STORM VS. LEVEL OF SECONDARY TREATMENT**

TABLE 7.3.2-2

**PROJECTED PRIMARY EFFLUENT**
**CONVENTIONAL POLLUTANTS**
**YEAR 2020**

| | Low Groundwater | | | High Groundwater | | |
|---|---|---|---|---|---|---|
| Primary Effluent | Average Day | Maximum Day | Storm | Average Day | Maximum Day | Storm |
| Flow - mgd | | | | | | |
| To Secondary Plant | 390 | 600 | 1,080 | 670 | 950 | 1,080 |
| To Plant Discharge | 0 | 0 | 70 | 0 | 0 | 190 |
| Total | 390 | 600 | 1,150 | 670 | 950 | 1,270 |
| TSS | | | | | | |
| To Secondary Plant | | | | | | |
| lb/day | 227,000 | 470,000 | 791,000 | 238,000 | 596,000 | 828,000 |
| Concentration mg/l | 70 | | | 43 | | |
| To Plant Discharge | | | | | | |
| lb/day | - | - | 50,000 | - | - | 109,000 |
| Concentration mg/l | | | 75 | | | 69 |
| BOD | | | | | | |
| To Secondary Plant | | | | | | |
| lb/day | 408,000 | 826,000 | 914,000 | 433,000 | 886,000 | 960,000 |
| Concentration mg/l | 125 | | | 77 | | |
| Plant Discharge | | | | | | |
| lb/day | - | - | 67,000 | - | - | 144,000 |
| Concentration mg/l | | | 100 | | | 91 |

Note: BOD and TSS loading include an allowance for solids processing sidestream.

TABLE 7.3.2-3

PROJECTED SECONDARY EFFLUENT
CONVENTIONAL POLLUTANTS
YEAR 2020

| Secondary Effluent | Low Groundwater | | | High Groundwater | | |
|---|---|---|---|---|---|---|
| | Average Day | Maximum Day | Storm | Average Day | Maximum Day | Storm |
| Flow - mgd | | | | | | |
| Secondary Component | 390 | 600 | 1,080 | 670 | 950 | 1,080 |
| Primary Component | 0 | 0 | 70 | 0 | 0 | 190 |
| Total | 390 | 600 | 1,150 | 670 | 950 | 1,270 |
| TSS | | | | | | |
| lbs/day | | | | | | |
| Secondary Component | 48,800 | 203,500 | 360,300 | 111,800 | 320,300 | 360,300 |
| Primary Component | 0 | 0 | 46,000 | 0 | 0 | 111,100 |
| Total | 48,800 | 203,500 | 406,300 | 111,800 | 320,300 | 471,400 |
| mg/L | 15 | | 42 | 20 | 40 | 44 |
| % Removed | 90 | 80 | 73 | 77 | 68 | 68 |
| BOD | | | | | | |
| lbs/day | | | | | | |
| Secondary Component | 48,800 | 203,500 | 360,300 | 111,800 | 320,300 | 360,300 |
| Primary Component | 0 | 0 | 60,700 | 0 | 0 | 146,500 |
| Total | 48,800 | 203,500 | 421,000 | 111,800 | 320,300 | 506,800 |
| mg/L | 15 | | 44 | 20 | 40 | 48 |
| % Removed | 91 | 81 | 68 | 79 | 70 | 61 |

Note: BOD and TSS loading include an allowance for solids processing sidestream.

TABLE 7.4.1-1

AVERAGE EFFLUENT
METAL LOAD (lb/day)
YEAR 2020

| Constituent | Influent Load | Primary Treatment % Removal | Primary Effluent | Secondary[1] Treatment % Removal | Total Effluent Load |
|---|---|---|---|---|---|
| Antimony | 16.2 | 30 | 11.4 | 60 | 6.5 |
| Arsenic | 7.6 | 25 | 5.7 | 50 | 3.8 |
| Boron | 1570.5 | 2 | 1539.1 | 5 | 1492.0 |
| Cadmium | 8.4 | 15 | 7.2 | 50 | 4.2 |
| Chromium | 88.5 | 40 | 53.1 | 76 | 21.2 |
| Copper | 399.8 | 35 | 259.9 | 82 | 72.0 |
| Cyanide (Total) | 112.0 | 10 | 100.8 | 60 | 44.8 |
| Lead | 69.5 | 46 | 37.5 | 57 | 29.9 |
| Mercury | 5.0 | 22 | 3.9 | 75 | 1.2 |
| Molybdenum | 21.3 | 10 | 19.2 | 50 | 10.7 |
| Nickel | 79.1 | 15 | 67.2 | 32 | 53.8 |
| Selenium | 53.3 | 10 | 47.9 | 50 | 26.6 |
| Silver | 18.0 | 30 | 12.6 | 90 | 1.8 |
| Zinc | 866.2 | 40 | 519.7 | 76 | 207.9 |

(1) Secondary Treatment Percent Removal includes removal in primary treatment.

## 7.4.2 ACID BASE NEUTRALS AND VOLATILE ORGANIC COMPOUNDS

Estimates of the mass of acid base neutrals in the raw wastewater were also based on the Fall and Spring sampling programs. Removal rates of the detected volatile organics at the Deer Island Treatment Plant have been estimated based on the EPA "Report to Congress" cited above and are presented in Tables 7.4.2-1 and 7.4.2-2. Most of the volatile listed are poorly removed in primary treatment. However, removal in the secondary process is equal to or greater than 90 percent. The portion of these volatile organics removed in the form of air emissions, sludge, and/or conversion to new compounds is not precisely known. Removal efficiencies have been assumed equal over all flow conditions, and primary effluent in 1999 has been assumed to be equal to the design year primary effluent.

Assessment of the impacts of the non-conventional pollutants on water quality at the outfall terminus points are to be performed as part of the outfall analysis and are described in Volume V, Effluent Outfall.

TABLE 7.4.2-1

AVERAGE EFFLUENT ACID BASE NEUTRALS LOAD (lb/day)
YEAR 2020

| Constituent | Influent Load | Primary Treatment % Removal | Primary Effluent | Secondary[1] Treatment % Removal | Total Effluent Load |
|---|---|---|---|---|---|
| Phenol | 64.2 | 20 | 51.4 | 95 | 3.2 |
| Benzyl Alcohol | 86.3 | NA[2] | 86.3 | 90[3] | 8.6 |
| 1,2 - Dichlorobenzene | 74.8 | NA | 74.8 | 90 | 7.5 |
| 2 - Methylphenol | 88.4 | NA | 88.4 | 90[3] | 8.8 |
| 4 - Methylphenol | 76.3 | NA | 76.3 | 90[3] | 7.6[2] |
| Benzoic Acid | 335.5 | NA | 335.5 | 90[3] | 33.5 |
| Napthalene | 52.5 | 0 | 52.5 | 95 | 2.6 |
| 2 - Methylnapthalene | 61.8 | NA | 61.8 | 90[3] | 6.2 |
| 2,4,5 - Trichlorophenol | 401.0 | NA | 401.0 | 90[3] | 40.1 |
| Dimethyl Phthalate | 80.2 | 24 | 61.0 | 95 | 4.0 |
| Diethyl Phthalate | 67.3 | 0 | 67.3 | 90 | 6.7 |
| N - Nitro-sodiphenylamine(1) | 86.3 | NA | 86.3 | 90[3] | 26.7 |
| Di-N-Butylphthalate | 68.4 | 0 | 68.4 | 90 | 6.8 |
| Butylbenzyl Phthalate | 63.7 | 0 | 63.7 | 95 | 3.2 |
| Bis (2 - Ethylhexyl) Phthalate | 78.3 | 0 | 78.3 | 90 | 7.8 |
| Di-N-Octyl Phthalate | 65.8 | 0 | 65.8 | 90 | 6.6 |

(1) Secondary Treatment Percent Removal includes removal in primary treatment.

(2) Where removal efficiencies are not available for primary treatment, no removal was assumed.

(3) Where removal efficiencies are not available for secondary treatment, 90% removal was assumed based on the chemical similarities with other constituents of known removal.

TABLE 7.4.2-2

AVERAGE EFFLUENT
VOLATILE ORGANIC LOAD (lb/day)
YEAR 2020

| Constituent | Influent Load | Primary Treatment % Removal | Primary Effluent | Secondary[1] Treatment % Removal | Total Effluent Load |
|---|---|---|---|---|---|
| Bromomethane | 62.3 | NA[2] | 62.3 | 95 | 3.1 |
| Methylene Chloride | 120.3 | 0 | 120.3 | 95 | 6.0 |
| Acetone | 419.7 | NA | 419.7 | 95 | 21.0 |
| Carbon Disulfide | 34.3 | NA | 34.3 | 95 | 1.7 |
| Trans - 1,2 Dichloroethene | 29.9 | 36 | 19.1 | 90 | 3.0 |
| Chloroform | 22.3 | NA | 22.3 | 90 | 2.2 |
| 2-Butanone | 102.8 | NA | 102.8 | 90[3] | 10.3 |
| 1,1,1 - Trichloroethane | 49.7 | 40 | 29.8 | 95 | 2.5 |
| Trichloroethene | 43.6 | 20 | 34.9 | 95 | 2.2 |
| Benzene | 16.5 | 0 | 16.5 | 95 | 0.8 |
| 4 - Methyl - 2 - Pentanone | 80.5 | NA | 80.5 | 90[3] | 8.1 |
| Tetrachloroethene | 61.7 | 0 | 61.7 | 90 | 6.2 |
| 1,1,2,2 - Tetrachloroethene | 34.3 | NA | 34.3 | 90 | 3.4 |
| Toluene | 71.3 | 0 | 71.3 | 90 | 7.1 |
| Chlorobenzene | 33.8 | NA | 33.8 | 90 | 3.4 |

TABLE 7.4.2-2

AVERAGE EFFLUENT
VOLATILE ORGANIC LOAD (lb/day)
YEAR 2020

(continued)

| Constituent | Influent Load | Primary Treatment % Removal | Primary Effluent | Secondary[1] Treatment % Removal | Total Effluent Load |
|---|---|---|---|---|---|
| Ethylbenzene | 33.4 | 0 | 33.4 | 95 | 1.7 |
| Styrene | 37.5 | 0 | 37.5 | 90 | 3.8 |
| Total Xylene | 107.0 | NA | 107.0 | 95 | 5.4 |

(1) Secondary Treatment Percent Removal includes removal in primary treatment.

(2) Where removal efficiencies are not available, for primary treatment, no removal was assumed.

(3) Where removal efficiencies are not available for secondary treatment, 90 percent removal was assumed based on the chemical similarities with other constituents of known removal.

# Section 8

# SECTION 8.0 SCREENING OF TREATMENT ALTERNATIVES

## 8.1 INTRODUCTION

This section summarizes the preliminary evaluation and screening of unit processes that were considered as treatment alternatives for the proposed Deer Island secondary wastewater treatment facility and the headworks facilities, and presents the treatment processes recommended for detailed evaluation. The detailed evaluation of alternatives is contained in Section 10 of this report.

Thirty-five unit processes were initially selected for preliminary, primary, secondary, and disinfection treatment alternatives. The processes were selected after considering a wide range of conventional and state-of-the-art treatment alternatives. The processes selected were considered viable for initial evaluation because of a demonstrated ability at large wastewater treatment plants, the ability to consistently meet treatment standards, and/or the flexibility to operate in various treatment modes under different hydraulic and loading conditions. This section of the report was developed in late 1986 and was based on preliminary sizing criteria that were later refined as shown in Section 10 of this report. The refinements are not considered major and the conclusions reached in the preliminary evaluation and screening phase are considered to be valid.

## 8.2 GENERAL PLANT DESIGN CRITERIA

### 8.2.1 INTRODUCTION

General plant design criteria are applicable to the overall layout and operation of the proposed Deer Island secondary wastewater treatment facility. Included in the general design criteria are the design flood elevations against which the plant must be protected and against which the plant must be fully operable; the definition of those facilities that are deemed essential and require emergency or back-up power; minimum standards of reliability for equipment and tankage; determination of the mode of inter-process liquid conveyance and the method of flow distribution to main treatment units; and development of general requirements for unit isolation and dewatering.

The general criteria were developed: through the review of published wastewater treatment plant design guidelines such as Wastewater Treatment Plant Design (MOP 8) prepared by WPCF and ASCE, Recommended Standards for Sewage Works (the Ten State Standards), and Guides for the Design of Wastewater Treatment Works (TR-16) prepared by the New England Interstate Water Pollution Control Commission; through a review of design criteria and operational data for selected large wastewater treatment facilities in the United States (identified in Table 8.2.1-1); and through a review of MWRA mitigation commitments.

### 8.2.2 DATUM PLANES

The base elevation utilized in the facilities plan is the MDC Sewer Datum. This is compatible with the datum previously used for the existing Deer Island and Nut Island treatment facilities.

Various datum planes are used in the Boston area, most commonly Mean Sea Level Datum (U.S.G.S. datum of 1929), Boston City Base, and the MDC Sewer Datum. The following table shows the relationship of the various datums to the MDC Sewer Datum.

DATUM PLANES

| To Convert From | To | Add |
|---|---|---|
| USGS Datum | MDC Sewer Datum | 105.62 ft |
| Boston City Base | MDC Sewer Datum | 99.97 ft |

### 8.2.3 TIDE LEVEL AND FLOOD PROTECTION

Commonly accepted wastewater treatment plant design guidelines, including the Ten State Standards and TR-16, indicate that a treatment plant should remain fully operational at flood levels that correspond to the 25-year storm event and must be protected against structural and equipment damage during a 100-year storm event. The Flood Insurance Maps prepared by the Federal Emergency Management Agency (FEMA) indicate that the maximum 100-year flood levels at Deer Island and Nut Island are 115.6 and 120.6 ft. The Nut Island level includes wave action, but the Deer Island level does not include wave action. (According to FEMA, wave heights on Deer Island were excluded from their analysis since breaking waves will be less than 3 ft, will cause minimal damage, and are not of concern to FEMA.) However, calculations performed according to FEMA methodology indicated that the maximum wave height on Deer Island would be 2 ft. This results in a total 100-year flood elevation, including wave action, of 117.6 ft at Deer Island.

Historical records indicate that sea level within Boston Harbor has been increasing at a rate of 0.014 ft per year. Based on this rise, the projected annual highest tides are expected to increase by 1.1 ft by the year 2020. Allowing for this increase in sea level, treatment components will be designed around a 100-year flood elevation of 119 ft at Deer Island and 122 ft at Nut Island.

Based on a frequency analysis of annual tides presented in the Boston Main Drainage Report (CDM, September 1967), and the projected increases in sea level, the 25-year flood elevation at which the Deer Island Treatment Plant must remain fully operational is elevation 115.7 ft.

TABLE 8.2.1-1
LARGE TREATMENT FACILITIES REVIEWED
FOR DESIGN AND OPERATION DATA

| Location | Average Design Capacity (mgd) |
|---|---|
| Blue Plains WWTP, Washington D.C. | 309 |
| Los Angeles County Joint Treatment Plant, CA | 350 |
| East Bay MUD, Oakland, CA | 120 |
| Hyperion Treatment Plant, Los Angeles, CA | 390 |
| San Francisco - Southeast WPCD, CA | 85 |
| West-Southwest STW, Chicago, IL | 1200 |
| Northside STW, Chicago, IL | 333 |
| Calumet STW, Chicago, IL | 354 |
| Wards Island WPCP, NYC, NY | 225 |
| Cedar Creek WPCP, Nassau County, NY | 40 |
| Detroit WWTP, | 840 |
| Jones Island WWTP, Milwaukee, WI | 120 |
| St. Paul, MN | 290 |

### 8.2.4 POWER FOR ESSENTIAL FACILITIES

The EPA technical bulletin entitled Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability indicates that two separate and independent sources of electrical power should be provided to a wastewater treatment works from either two separate utility substations or from a single substation and onsite generators. As a minimum, the capacity of the backup power source should be sufficient to operate all essential facilities during peak wastewater flow conditions together with critical lighting and ventilation.

The essential facilities that require power at all times include the following: preliminary treatment, influent pumping, primary treatment, disinfection, sludge processing, and critical lighting and ventilation.

### 8.2.5 EQUIPMENT AND TANKAGE RELIABILITY

#### Pumps and Mechanical Equipment

All pumps and mechanical units will be provided in units of up to five: three or fewer units available to handle peak design flow and/or load, one standby unit, and one unit assumed to be undergoing long-term maintenance. All new units are subject to this criterion or an equivalent criterion.

The existing main pumping station on Deer Island is to be retained, but cannot meet this criterion. The main pumping station will be equipped with ten pumps: nine capable of handling peak flow, with one standby pump. Special backup will be provided through onsite storage of complete replacement units including pumps, drives, shafts, and couplings.

#### Grit Chambers and Sedimentation Basins

Backup tankage for grit removal, primary and secondary clarifiers will take into account the fact that at any given time, one or more units will not be operational because of maintenance requirements. Since operational adjustments will not effectively replace tanks out of service, consistent grit and solids removal in the grit chambers and the clarifiers requires additional units to compensate for the lost capacity of the inoperable tankage. Operational data from selected large municipal wastewater treatment facilities with clarifiers was reviewed. Based on this review, 10 to 15 percent of the total clarifiers were typically down for maintenance at any given time. Total tankage for grit removal and primary and secondary clarifiers will include approximately 12 percent allowance for standby.

#### Other Tankage

Aeration basins and disinfection contact basins will not require any standby units. The secondary aeration tankage components do not require backup due to the inherent process flexibility via operator modifications in operational characteristics, such as the F:M ratio and recycle rates.

Disinfection contact units are normally sized for peak rates. Redundancy in contact chambers for disinfection is not commonly provided; however, feed and dissolution equipment for disinfection chemicals will have the standby specified for mechanical equipment.

### 8.2.6 GENERAL METHODOLOGY FOR FLOW DISTRIBUTION AND INTERPROCESS CONVEYANCE

Main treatment units will be designed as four batteries. Flow distribution to the batteries will be accomplished through positive flow splitter boxes. Distribution to individual treatment units will occur via influent channels with inlet controls designed to impart sufficient hydraulic headloss, thus ensuring equal distribution of flow to each unit.

Interprocess flow conveyance will occur through a set of four enclosed conduits. Flow flexibility will be achieved with these four channels since each channel will be able to distribute flow to and from the four corresponding batteries of each unit operation and maintain battery segregation through the secondary plant if desired. Scum and foam removal will be provided in all channels and tanks with a trapped free surface.

### 8.2.7 REQUIREMENTS FOR UNIT ISOLATION AND DEWATERING

Means of unit isolation and dewatering will be provided for all unit processes. Influent flow to each unit will be controlled by sluice or slide gates with rising stems for visible status. Each tank will have the capability to be drained, with each unit process or battery having a central tank drain system for this purpose. The drain time for each tank will not be greater than 6 hours so that the procedure can be accomplished in one shift. As required, tanks will be designed to protect against flotation through the use of underdrains and flap valves.

## 8.3 SCREENING CRITERIA

### 8.3.1 INTRODUCTION

Each unit process was evaluated on the basis of area requirements, experience, and performance at large municipal wastewater treatment facilities, and relative capital and operating costs. Each unit process was also compared, using fourteen criteria, to a reference unit process that accomplishes the same function. The comparison considers the utilization of the unit process at MWRA facilities and may not necessarily represent the evaluation at other treatment facilities or a generic comparison of unit processes. The examination of the unit processes is arranged by functional areas: preliminary treatment, primary treatment, secondary treatment, and disinfection. The reference processes for preliminary treatment are aerated grit chambers and catenary screens; for primary treatment, circular clarifiers; for secondary treatment, air activated sludge and circular secondary clarifiers; and for disinfection, the use of liquid chlorine. Air emission control equipment is considered as part of any unit process where its use is required.

The following paragraphs define each criterion and describe how the criterion was used to screen unit processes. Table 8.3.1-1 summarizes the evaluation criteria and the ratings for each.

### 8.3.2 AREA REQUIREMENTS

Area requirements were estimated for each unit process by use of process sizing criteria. The criteria for each unit process are presented in Section 8.4. A plant annual average flow of 500 mgd was utilized to determine the volume and/or surface area required. Since all unit processes require multiple units, the space between units was taken into account in the area requirements. However, the total area presented does not include area for support facilities, roadways, or interprocess flow conveyance. Area requirements should be compared to unit processes accomplishing the same function. Unit processes requiring significantly more area than the reference unit process will likely be eliminated from further consideration since land area available at Deer Island is limited.

### 8.3.3 MUNICIPAL WASTEWATER EXPERIENCE AND PERFORMANCE

The operational history and performance of each unit process were evaluated at large municipal wastewater treatment facilities. Some of the information reviewed included the number of years of operation, size of facilities, history of operation and maintenance, problems encountered, ability to handle peak flows, and performance as measured by process effluent quality. If a unit process had not been demonstrated successfully at a large municipal wastewater treatment facility, it was not selected for detailed evaluation.

### 8.3.4 CAPITAL COSTS AND OPERATION AND MAINTENANCE COSTS

For both of these cost criteria, the unit processes were compared on the basis of relative costs. The basis of comparison was the reference unit process presented above. Several sources were used to develop relative costs including published cost curves, actual bid costs, and costs supplied by manufacturers. Most unit processes that achieve the same function are similar in costs.

Only unit processes that are significantly lower or higher in costs than the reference unit process will be noted in the discussion. If the capital or operation cost of a particular unit process exceeds the reference unit cost by 50 percent, that unit process would most likely be eliminated from further consideration.

### 8.3.5 RELIABILITY

Reliability is defined as the level of assurance that the unit process will consistently achieve the required degree of treatment under the expected range of operating conditions. This criterion takes into account the track record of the unit process at other large municipal wastewater treatment facilities. For this study, unit processes are rated using one of three levels of reliability: "high", "average", or "low". Unit processes ranked "high" consistently achieve the required degree of treatment. A unit process ranked "average" can be expected to

## TABLE 8.3.1-1

## SUMMARY OF EVALUATION CRITERIA FOR UNIT PROCESS EVALUATION

| CRITERIA | RATINGS | | |
|---|---|---|---|
| Reliability | low | average | high |
| Flexibility | low | average | high |
| Constructibility | difficult | average | -- |
| Safety | special | normal | -- |
| Operators Required | greater | average | fewer |
| Operational Complexity | difficult | average | simple |
| Power Efficiency | low | average | high |
| Auxiliary Needs | (no auxiliary need or specific need) | | |
| Residuals Aspects | difficult | average | good |
| Spoils Disposal | difficult | average | simple |
| Air Emissions Control | difficult | averge | none |
| Noise Control | difficult | average | good |
| Aesthetics | -- | average | good |
| Effluent Quality | low | average | high |

have occasional process upsets but normally meets standards and is comparable to the reference unit process. A unit process ranked "low" has a record of poor reliability or represents a new, unproven process.

### 8.3.6 FLEXIBILITY

Flexibility is defined as the degree to which a unit process will operate under upset conditions or major changes in flows or loadings. An upset condition may be defined as out of normal range but anticipated. For this study, unit processes are rated using one of three levels of flexibility: "high", "average", or "low". A unit process ranked "high" is not significantly affected by upset conditions or changes in flow or loadings. Unit processes ranked "average" are sometimes affected by these conditions, and unit processes ranked "low" cannot be expected to achieve design requirements during upset conditions such as changes in flow or loadings.

### 8.3.7 CONSTRUCTIBILITY

Constructibility takes into account many aspects of the construction of a unit process. These include the degree of construction difficulty, duration, and scheduling. The constructibility of a unit process will also be influenced by the degree to which supporting barge and staging areas are required. For this study unit processes are rated as presenting "difficult" conditions for construction or presenting "normal" conditions.

### 8.3.8 SAFETY

Safety is a criterion used to judge the level of precautions needed to reduce risks to plant personnel or the surrounding community. For some unit processes special safety precautions are required during operation. For other unit processes only normal safety precautions are required for operation. Therefore, two levels of safety are used in rating unit processes in this report: "special" and "normal".

### 8.3.9 OPERATORS REQUIRED

This criterion is a measure of the relative number of operators and maintenance personnel required to successfully operate and maintain the unit process as compared to the reference unit process. For this study three levels of operators required are cited: "greater," which indicates a staff larger than the average required for the reference unit process; "average" number; or "fewer" number than average required to operate and maintain the reference unit process.

### 8.3.10 OPERATIONAL COMPLEXITY

Operational complexity is defined as the degree of difficulty in the maintenance and control of a unit process. It is directly proportional to the level of skill required by plant operators to successfully operate the unit process. Average operational complexity means the unit process requires similar skills compared to the reference unit process. For this study three

levels of operational complexity are cited: "difficult", "average," and "simple". The simple rated unit process will not require as high a skill level for operators in order to operate successfully. A difficult unit process will require more highly skilled operators, compared to the reference unit process for successful operation.

### 8.3.11 POWER EFFICIENCY

Within each functional area power is required to achieve the desired degree of treatment. A unit process rated as "high" for power efficiency uses less power than the reference process to achieve similar degrees of treatment. A unit process rated "average" is similar in power needs to the reference process. A unit process rated as "low" for power efficiency uses more power than the reference process to achieve similar degrees of treatment.

### 8.3.12 AUXILIARY NEEDS

Certain unit processes require significant auxiliaries to support the process, such as plant water for washing or chemical feed facilities. Needs were noted for these unit processes. If the unit process does not require any auxiliary equipment or utilities, the notation "none" was entered.

### 8.3.13 RESIDUALS ASPECTS

Residuals aspects are defined as the level of difficulty of collection, processing, and disposal of residuals. Residuals include primary and secondary sludges, scum, grit, and screenings. This criterion takes into account both the quality and quantity of residuals generated by unit processes. A unit process rated "difficult" generates a greater amount of residuals or residuals more difficult to collect, process, or dispose of compared to the reference unit process. A unit process rated "average" is similar to the reference unit process in residuals aspects. A unit process rated "good" either generates fewer residuals compared to the reference unit process, or achieves the collection, processing, and disposal of those residuals more easily than does the reference unit process.

### 8.3.14 SPOILS DISPOSAL

Construction of unit processes will require excavation of soil and subsequent disposal at either on-island or off-island locations. Unit processes that require minimal excavation will reduce the volume of spoils requiring disposal. For this study, spoils disposal is rated as "difficult" compared to the reference unit process, "average" if it is similar to the reference unit process, or "simple" if it produces significantly less spoils than the reference unit process.

### 8.3.15 AIR EMISSIONS CONTROL

Air emissions control is defined as the potential for generating air emissions and therefore, indirectly, as an indication of the level of control necessary to limit air emissions from a

unit process. Volatile material is emitted from nearly all unit processes. Production is greater where turbulence is greater. For these unit processes the level of control is greater to minimize the effects of these emissions. For this study, a unit process rated "difficult" has a greater potential for emissions and requires a complex method to collect air emissions, or the area over which collection is required is extensive compared to the reference unit process. A unit process rated "average" emits a similar amount of pollutants and requires similar control as compared to the reference unit process. A unit process rated "none" does not produce significant air emissions and is not normally equipped with air emission control equipment.

### 8.3.16 NOISE CONTROL

Noise control is defined as the ease of controlling the noise generated during operation of a specific unit process. For this study, a unit process rated "difficult" has the potential to create a high noise level and requires a greater level of control compared to the reference unit process. A unit process rated "average" produces noise and requires noise control mitigation to about the same degree as the reference project. A unit process rated "good" produces only low levels of noise that are simple to control compared to the control of the reference unit process.

### 8.3.17 AESTHETICS

Aesthetics is defined as the relative visual impact of a unit process on the surrounding communities and adjacent marine users. Unit processes are rated as either "good" or "average". A unit process ranked "good" is normally housed in a building where the building itself can be treated architecturally, or the process has a very low profile compared to the reference unit process. A unit process ranked "average" may have a high profile, may have a large amount of exposed equipment, or may have other attributes that would require normal screening or other architectural treatment.

### 8.3.18 EFFLUENT QUALITY

Effluent quality is defined as the relative impact of a unit process on downstream unit processes or the receiving water. A unit process rated "high" achieves results better than the reference unit process. A unit process rated "average" is similar to that achieved by the reference unit process. A unit process rated "low" does not meet the same standards as the reference unit process.

## 8.4 EVALUATION AND SCREENING OF TREATMENT UNIT PROCESSES

### 8.4.1 INTRODUCTION

The purpose of this section is to present the results of the preliminary evaluation and screening of unit processes that were considered as treatment alternatives at the headworks and Deer Island treatment facility. The text presumes a level of familiarity with wastewater

treatment and omits a description of the various unit processes. However, a brief description of each unit process considered is found in Appendix C of this report.

### 8.4.2 PRELIMINARY TREATMENT

Introduction

Preliminary treatment for the new treatment facilities will be performed at the existing remote headworks facilities of Chelsea Creek, Ward Street, and Columbus Park, and at Deer Island and Nut Island. The remote headworks facilities will be utilized for the entire planning period. Alternatives considered for the existing screening and pumping facilities at the Winthrop Terminal headworks located on Deer Island were to either retain or relocate them if required by the overall layout of the treatment plant or plant hydraulics. If these facilities are relocated, the screens being installed under the First Track program would be salvaged and reinstalled. The aerated grit chambers at the Winthrop Terminal headworks will be abandoned regardless of the headworks' final location. New grit facilities will be constructed on Deer Island to remove grit from the wastewater flowing through the Winthrop Terminal headworks, and from wastewater that passes through the other three existing remote headworks. The need for grit removal facilities on Deer Island, placed in series with the remote headworks, is demonstrated by a significant quantity of grit deposited in the plant's preaeration channels and included in the primary sludge. Preliminary treatment for the South collection system would be located on Nut Island. The treatment processes at Nut Island would include screening followed by grit removal.

Preliminary unit process sizes and layouts were developed to determine estimated facility area requirements. The estimated area requirements of the new grit removal facilities for Deer Island include tank area and grit handling facilities. The estimated area requirements for the Nut Island headworks facility include grit chamber and screening area as well as grit and screenings handling requirements. The space required for screening options, though varying in height and plan area, is small when compared to the requirements for grit removal.

The unit processes considered as preliminary treatment options are discussed in the following section. Included is a discussion of the unit's wastewater-related operating history and performance, the required land area, relative costs, and the recommendation for acceptance or rejection for further analysis.

Screening and grit removal processes not considered included screens using submerged sprockets or back clean operation, which do not provide the reliability and removal effectiveness of the catenary and climber screens, and grit removal in detritus tanks which requires more extensive handling to separate the grit from settled organic matter. The goal of the grit removal systems evaluated is to remove grit while allowing as much of the organic material as possible to be carried to the downstream processes for treatment. These residuals will be processed and disposed of separately.

Catenary Screens

Catenary screens have operated successfully at many large wastewater treatment and pumping facilities for over 20 years. The Chicago North Side Sewage Treatment Plant, treating an average daily flow of 290 mgd and peak flow of 480 mgd, includes four screens 15 ft wide. The Detroit Wastewater Treatment Plant with a design peak flow of 1,050 mgd uses six 12-ft wide screens. In addition, catenary screens are installed at the existing Nut Island treatment plant. The sizing criteria used for screen comparison is 150 mgd per screen.

The catenary unit screen is sturdy, dependable, and requires low maintenance. For these reasons the catenary bar screen will be carried forward for further analysis.

Climber Screens

The climber screen was developed in Germany in the mid-1960's and has been installed in many wastewater facilities throughout the United States and Europe. The City of New York's Department of Environmental Protection installed its first climber unit in 1983, resulting in good screening capture. In 1987, six more units are due to be in operation. In New Orleans, Louisiana, a climber screen has been installed in a channel 17 ft wide by 15.5 ft deep. Climber screens will be installed at the existing MWRA headworks facilities under the fast-track improvements. The Chelsea Creek screen inlet channels are 12.0 ft wide and 10.5 ft deep.

The size of the channel for the catenary and climber screens would be the same. The plan area of the screens is not a significant factor when comparing the area required for a headworks facility. The climber screen requires approximately 10 ft more headroom than does the catenary type. Design considerations can minimize the impact this would have on the height of the headworks facilities.

Like the catenary screen, this screen is rugged, durable, and easy to operate. Although the climber screen may be slightly more expensive than catenary screens, the climber bar screen will be evaluated further.

Horizontal Flow Grit Channel

The horizontal flow channel method for grit removal has been utilized at large treatment facilities for many years. The North Side sewage plant in Chicago (480 mgd peak flow) uses 12 horizontal flow grit channels successfully. The Nut Island treatment plant has used horizontal flow channels since 1952. Velocity is controlled by a parshall flume rather than by an effluent weir or gate. The North System remote headworks facilities of Ward Street, Columbus Park, and Chelsea Creek also use horizontal flow grit channels, which have proven adequate to prevent significant grit buildup in the tunnels. The MWRA facilities have had limited success in providing efficient grit removal, utilizing the existing horizontal flow channels, as evidenced by significant grit accumulation in the preaeration tanks at both the Nut Island and Deer Island treatment facilities.

The area required for a new headworks facility on Nut Island, which would include the pretreatment operations of screening and grit removal by horizontal flow grit channels to handle South System peak flows, would cover approximately 0.8 acres. A headworks facility on Deer Island containing horizontal flow grit channels to handle North System flows would cover approximately 1.3 acres. The sizing of the grit channels was based on maintaining a 1 fps horizontal velocity at peak flow.

The advantage of horizontal flow grit channels, when compared to the reference unit process of aerated grit chambers, is that air is not required for treatment. This saves on energy use, and the extent to which odor and air emissions equipment would be required.

Disadvantages of this process are the larger area required when compared to other grit removal processes, the variability of removal efficiencies over normal flow ranges, and the potential for increased presence of organics in the settled grit. The horizontal flow channels are not able to maintain the proper horizontal velocity when flows are low. The organic content of the grit would be higher than that of the aerated system because there is no means to keep the organics in suspension during low flow periods. Organic material in the grit may cause odor problems during storage and disposal of the grit. These disadvantages led to the decision to eliminate horizontal flow grit channels from further consideration for implementation in new facilities at Deer Island and Nut Island.

Aerated Grit Chamber

Aerated grit chambers have a long history of use at major wastewater treatment facilities. The Blue Plains (Washington, D.C.) East and West treatment plants treat on the average about 160 mgd and 140 mgd of flow, and peak flow of 290 mgd and 600 mgd respectively. The four channels used at the West plant and the 12 channels used at the East plant operate successfully over a wide range of flow. Both plants use an overhead clamshell bucket system to remove grit.

The land area needed for a new headworks facility containing screens and aerated grit chambers on Nut Island would cover approximately 0.6 acres, while Deer Island grit facilities would require approximately 1.0 acre. The aerated grit chambers were sized to provide a detention time of 3 minutes during peak flow conditions.

The positive aspects of the aerated grit chamber process are its reliability to achieve the design removal efficiencies over normal and unusual flow conditions, and its ability to keep organic material in suspension even during low flow conditions, thus minimizing the organic content of the residual grit. The organics are kept in suspension through control of the air application rates.

Disadvantages of this process are the costs associated with supplying air to the process, and the air emissions control process that might be necessary. The operation and maintenance costs of an aerated grit removal system would be approximately twice as much as the velocity controlled and centrifugal grit removal systems. The size and extent of odor and air emissions

control might be greater than the other grit removal options due to the air stripping of volatile compounds in the aerated grit process.

The aerated grit removal operation will be studied in further detail for use at Nut Island and Deer Island because of its proven record, removal flexibility, and similar area requirements compared to the centrifugal grit option.

Centrifugal Grit Chamber

Over two hundred centrifugal grit chambers have been successfully operating in the United States since their introduction in the mid-1970's. There is no long-term use experience, however, for treatment plants larger than 100 mgd average daily flow. Two 50-mgd grit chambers are in operation at the Tuscon, Arizona wastewater treatment plant, which currently treats 35 mgd of flow on an average day. The largest centrifugal units currently installed are capable of handling 70 mgd of flow and were placed in operation at the Milwaukee Jones Island Plant in 1986.

The land area needed for headworks facilities containing the required number of centrifugal grit chambers and screening facilities for Nut Island would be approximately 0.5 acres. Approximately 1.0 acre would be required for centrifugal grit chambers and grit handling facilities on Deer Island.

The centrifugal process has several positive features. Like the aerated grit chamber, this process would be very reliable over a wide range of flow and loading conditions. The design includes a rotating paddle which provides an effective means to keep organic material in suspension. The centrifugal system would cost about one half as much to operate and maintain as the aerated system, primarily because of the much lower power requirements. Also, the centrifugal system would be expected to produce fewer air emissions than the aerated system. The primary concern regarding this system is that there are not many large capacity units currently in use. However, the sound operational concept of the centrifugal units and the similarity of area requirements when compared to the aerated grit option justify more detailed study of this option.

Cyclone Primary Sludge Degritting (Deer Island Only)

The process of removal of grit from primary sludge using cyclone degritters is used at many wastewater treatment plants. This is the standard practice of all of the New York City treatment plants, which collectively treat over one billion gallons of flow per day.

The area of a building for the cyclone degritters would be approximately 1.0 acre. Removal of grit from primary sludge by cyclone degritters has several advantages over the other grit removal processes. This process limits exposure of the wastewater to the atmosphere, thereby reducing some of the air emissions concerns. Also, the building could more easily be placed above grade compared to the other options, resulting in smaller quantities of earth excavated for construction.

The disadvantages of the primary sludge degritting process is that the system brings grit into the primary clarifiers and requires primary sludge thickening. The presence of grit in the primary treatment system could cause high levels of wear and abrasion on the primary treatment equipment. This option is particularly undesirable when using chain and flight sludge removal mechanisms in the covered rectangular clarifier considered for primary and secondary sedimentation. This particular disadvantage led to the decision to eliminate the cyclone primary sludge degritting process from further consideration.

Preaeration

Preaeration has been used at treatment plants to enhance BOD and suspended solids removal in primary sedimentation basins. The current use of this process is not widespread. To achieve the process goals, detention times of 20 to 40 minutes are required. Preaeration basins for a new Deer Island treatment plant would cover approximately 33 acres based on a 40 minute detention time at average daily flow.

The gains in treatment enchancement do not justify the area required to provide preaeration. therefore this process is not recommended for further detailed study.

Matrix Evaluation

Table 8.4.2-1 presents the evaluation matrix for preliminary treatment options. Aerated grit chambers constitute the reference unit process to which the other unit processes are compared.

## 8.4.3 PRIMARY TREATMENT

Introduction

Primary treatment removes readily settleable solids and floating material and thus reduces the suspended solids content of the wastewater as well as the BOD associated with the suspended solids. Primary treatment typically removes 30-60 percent suspended solids and 15-35 percent of BOD.

Six unit processes were considered as primary treatment options. The Final Environmental Impact Report on Siting of Wastewater Treatment Facilities for Boston Harbor (the FEIR) allocated approximately 20 acres of land for primary treatment at the Deer Island treatment facility. Therefore, the area required for each unit process is one of the prime factors for accepting or rejecting the unit process. Below are the unit processes considered as primary treatment options. Included is a discussion of the unit's wastewater-related operational history and performance, the applicable land requirement at the treatment facility, and documentation in support of the unit process being accepted for or rejected from further evaluation as a treatment alternative at the Deer Island treatment facility.

## TABLE 8.4.2-1

## EVALUATION MATRIX FOR GRIT REMOVAL UNIT PROCESSES

| | Aerated Grit Chamber* | Horizontal Flow Grit Channel | Centrifugal Grit Chamber | Cyclone Primary Sludge Degritting |
|---|---|---|---|---|
| Reliability | average | low | average | average |
| Flexibility | high | low | high | average |
| Constructibility | normal | normal | normal | normal |
| Safety | normal | normal | normal | normal |
| Operators Required | average | average | average | greater |
| Operational Complexity | simple | simple | simple | average |
| Power Efficiency | average | high | high | average |
| Auxiliary Needs | process air | none | none | sludge thickening |
| Residuals Aspects | good | difficult | good | average |
| Spoils Disposal | average | average | average | simple |
| Air Emissions Control | difficult | average | average | average |
| Noise | average | average | average | average |
| Aesthetics | NA | NA | NA | NA |
| Effluent Quality | average | low | average | average |

*Reference unit process

Primary Clarifier, Rectangular

Rectangular primary clarifiers are in widespread municipal use. The units have been used at many treatment facilities with flows in excess of 100 mgd. Rectangular clarifiers sized at an average-day overflow rate of 800 gpd/$ft^2$ require 25 acres of land at the treatment facility. Rectangular clarifiers were accepted for further evaluation as the unit is a proven and effective form of treatment at the facility. Furthermore, rectangular clarifiers are land efficient. During the detailed evaluation, various overflow rates will be evaluated in order to achieve the highest level of primary treatment.

Primary Clarifier, Circular

Circular primary clarifiers are also in widespread municipal use. The units have been used at facilities with flows in excess of 100 mgd. Circular clarifiers sized at an average-day overflow rate of 800 gpd/$ft^2$ require 38.5 acres of land at the treatment facility. Circular clarifiers have been rejected as a primary treatment option because they require about 40 percent more area than rectangular units and are no more efficient than rectangular units. Furthermore, during the evaluation and screening of rectangular and circular clarifiers, large municipal wastewater treatment facilities were contacted to determine the type of clarifiers used for primary and secondary treatment as shown on Table 8.4.3-1. The analysis of the survey concluded that most of the larger facilities use rectangular clarifiers because of the savings in land.

Primary Clarifier With Chemical Addition

Chemical addition to wastewater prior to primary sedimentation has been used at treatment facilities of various sizes to enhance suspended solids removal. It is considered slightly more complex, requires more operation and maintenance, and produces more sludge compared to conventional sedimentation. Additionally, the sludge produced is often more difficult to process. The process is principally used at treatment plants with effluent phosphorus requirements. Primary treatment with chemical addition is rejected as a treatment option because of the complexity involved in the process and the significant quantity of poorer quality sludge generated.

Tray Clarifiers

Tray systems are primarily used in the field of water treatment. When used for wastewater treatment, the wastewater passes horizontally through one portion of the tank, then passes vertically for a second horizontal pass through the tank. Tray clarifiers require 14 acres of land when sized at an average-day overflow rate of 800 gpd/$ft^2$. Tray systems are rejected as a primary treatment option because they are more difficult to construct, are more costly than conventional sedimentation, and have not been used in municipal wastewater treatment.

TABLE 8.4.3-1

## TYPES OF CLARIFIERS USED AT MAJOR WASTEWATER TREATMENT PLANTS

| PLANT | AVERAGE DESIGN CAPACITY (mgd) | PRIMARY CLARIFIERS | | SECONDARY CLARIFIERS | |
|---|---|---|---|---|---|
| | | Rectangular | Circular | Rectangular | Circular |
| Blue Plains, WWTP, Washington, D.C. | 309 | | X | X | |
| West-Southwest STW Chicago, IL | 1200 | X | | | X |
| Northside STW, Chicago, IL | 333 | | X | X | |
| Calumet STW, Chicago, IL | 354 | X | | X | |
| Detroit WWTP, MI | 840 | X | X | | X |
| East Bay MUD, Oakland, CA | 120 | X | | | X |
| LA County Joint Treatment Plant | 350 | X | | X | |
| Hyperion Treatment Facility, Los Angeles, CA | 390 | X | | X | |
| San Francisco-SE WPCD, CA | 85 | X | | | X |
| St. Paul, MN | 290 | X | | X | |
| New York City WPPCP's (8 largest) | 1190 | X | | X | |

Stacked Clarifiers

Stacked clarifiers are operated at a number of municipal wastewater treatment facilities in Japan. Wastewater is passed through only one compartment. There are two separate compartments per tank and they are very similar to conventional units. Stacked clarifiers, sized at an average-day overflow rate of 800 gpd/$ft^2$, require 14 acres of land. Stacked clarifiers are accepted as a primary treatment option because of their economy of land area. However, their construction may be more difficult compared to conventional sedimentation tanks.

Inclined Tube Settlers

Inclined tube settlers have been used at water treatment facilities of various sizes but have not been used extensively in wastewater treatment. Tube settlers, sized at an average day overflow rate of 1200 gpd/$ft^2$, require 27 acres of land at the treatment facility. Tube settlers are rejected as a primary treatment option because of a lack of statistically proven operational data at large wastewater treatment facilities. Furthermore, they require more maintenance and are more costly than conventional rectangular clarifiers.

Matrix Evaluation

Table 8.4.3-2 presents the evaluation matrix for primary treatment options. Circular primary clarifiers constitute the reference unit process to which other unit processes are compared.

## 8.4.4 SECONDARY TREATMENT

Introduction

Secondary treatment removes the remaining organic matter not removed in primary treatment. Secondary treatment is normally a two-phase process in which biological degradation and subsequent sedimentation work in conjunction to reduce the BOD and suspended solids concentration to 30 mg/l or less.

Secondary treatment of wastewaters can be conducted with or without the use of primary treatment. The inclusion of primary treatment reduces the loads to the secondary portion of the plant and thus reduces the required size of that secondary portion. The following presents a comparison evaluation of secondary treatment with and without primary treatment preceding it.

The comparison of secondary treatment with and without primary treatment was based on the flows, wastewater loads, and unit process sizing criteria used for detailed evaluation of the screened alternatives in Section 10. Secondary treatment was based on the use of air activated sludge. The activated sludge system without primary treatment was based on maintaining the same 3.2 day SRT used for the air activated sludge system in the evaluation of detailed alternatives. The yield and decay coefficients for the no-primary system were taken to be 1.10

**TABLE 8.4.3-2**

**EVALUATION MATRIX FOR PRIMARY TREATMENT UNIT PROCESSES**

| | Rectangular Tank | Circular Tank* | Chemical Addition | Tray Clarifiers | Stacked Clarifiers | Tube Settlers |
|---|---|---|---|---|---|---|
| Reliability | average | average | low | low | average | low |
| Flexibility | average | average | high | low | average | low |
| Constructibility | average | average | average | difficult | difficult | average |
| Safety | normal | normal | normal | normal | special | normal |
| Operators Req. | average | average | greater | average | average | greater |
| Operational Complexity | average | average | difficult | average | average | average |
| Power Efficiency | average | average | average | average | average | average |
| Auxiliary Needs | none | none | chemical feed equip. | none | none | none |
| Resid. Aspects | average | average | difficult | average | average | average |
| Spoils Disposal | average | average | average | average | average | average |
| Air Emissions Control | average | average | average | average | average | average |
| Noise | average | average | average | average | average | average |
| Aesthetics | average | average | average | average | average | average |
| Effl. Quality | average | average | high | average | average | average |

*Reference unit process

mg VSS/mg BOD removed and 0.08/day. Comparative vaues with primary treatment were 0.70 and 0.075 respectively. The same oxygen demand per lb of BOD removed in aeration was used with and without primary treatment.

A comparison of capital and operating costs with and without primary treatment is presented below:

| | With Primary Treatment | Without Primary Treatment |
|---|---|---|
| Capital Costs (in millions) | | |
| Primary | $182 | --- |
| Secondary | 390 | $586 |
| Total | $572 | $586 |
| Operating Costs (in millions) | | |
| Primary | $ 1.71 | --- |
| Secondary | 5.62 | $ 7.67 |
| Total | $ 7.33 | $ 7.67 |

The above capital and operating costs include costs associated with sludge removal and pumping, air supply, treatment of air emissions, process instrumentation, and operation and maintenance. The costs with and without primary treatment are essentially equal, although the option with primary treatment is slightly less expensive in terms of both capital and operating costs. However, these costs do not include any capital or operating costs associated with solids handling and disposal. Primary sludge exhibits handling characteristics far superior to those of waste activated sludges. Sludge processing is always enhanced with the inclusion of primary sludges. Inclusion of the capital and operating costs associated with sludge disposal would increase the difference between the above costs for primary and no primary treatment in favor of the primary treatment alternative. The MWRA's residuals consultant has stated that primary treatment is essential to their solids handling program. The elimination of primary treatment would, they state, have significant adverse impacts on the residuals programs that they are considering.

Based on the yield factors assumed for sludge production in secondary treatment and the removal rates used for primary sedimentation (Section 7), the use of primary treatment results in slightly less sludge production than secondary treatment without primary treatment. This was confirmed by reviewing operating records of several large facilities in the United States. New York City plants, which treat wastewater in strength very similar to the MWRA's, produce about 7% more sludge per lb of BOD removed in their plants without primary treatment than in their plants with primary treatment. A plant in the midwest treating 30 mgd operated with and without primary treatment and produced essentially equal amounts of sludge in either mode.

There are no space savings associated with the removal of primary treatment. The reduction in area associated with the absence of primaries was offset by increased area requirements for aeration tanks and secondary clarifiers.

Operationally, the inclusion of primary treatment decreases the effect of organic loading changes on the secondary process. Plant staff has from one to two hours to react to changes in incoming loads resulting from storms. Skimmings and rags can have significant adverse impacts on aeration and secondary clarifiers in the absence of primary treatment.

The inclusion of primary treatment prior to secondary is favored from cost, operational and sludge processing standpoints. Additionally, the alternative without primary treatment offers no advantages in terms of area used. Since the alternative of no primary treatment offers no cost, operational, or space-savings advantages, it was dropped from further consideration.

The loading criteria and area requirements presented subsequently in this section are based on primary treatment before secondary treatment.

Twelve unit processes were considered as secondary treatment alternatives. Six activated sludge processes, three fixed film processes, and three other biological or physical-chemical processes were evaluated. Several types or configurations of the secondary sedimentation processes were also evaluated. The FEIR allocated approximately 50 acres of land for secondary treatment at the Deer Island treatment facility. Therefore, the area required for each unit process is a prime reason for accepting or rejecting a unit process. The unit processes considered as secondary treatment alternatives are discussed in the following. Included is a discussion of the unit's wastewater-related operational history and performance, and the applicable land requirements at the treatment facility.

Activated Sludge, Air

This technology is highly developed and widely used, particularly in the municipal wastewater treatment field. Air activated sludge systems have been used for over 60 years. Usage includes numerous facilities with flows in excess of 100 mgd. A system sized at a detention time of 3.5 hours requires 15 acres of land at the treatment facility. The air activated sludge process is accepted for further analysis as a secondary treatment option because of its widespread use and proven performance.

The selector process for improved sludge settling is under active study and development at pilot and full scale plants. Selectors are normally used as an integral part of most biological nutrient removal processes such as the A/O process or the Bardenpho process. but the selector component may be employed where nutrient removal is not required in order to enhance the settleability of the activated sludge. The selector process was considered during the detailed evaluation of alternatives for all activated sludge processes.

As part of the evaluation and screening of air activated sludge, three types of aeration systems were evaluated: fine bubble diffused air; coarse bubble diffused air; and mechanical aeration. An evaluation of design criteria, capital cost, and operating and maintenance costs, was completed for each unit process. The analysis concluded that fine bubble diffused air systems are cost-effective compared to the other two methods. Fine bubble diffused air systems will be used as the aeration method for detailed analysis.

Activated Sludge, Oxygen

This technology is also highly developed and widely used. Currently over 100 municipal and industrial treatment plants use this treatment technique. Flows at some of these facilities are in excess of 100 mgd. Experienced operators are required for operation and maintenance of the oxygen-generation equipment. The pure oxygen system, sized at a detention time of 1.4 hours, requires 5 acres of land at the treatment facility. This decrease in area, in comparison to the air activated sludge system, is offset by an increase in area for secondary clarifiers. Total system costs are about the same as for air activated sludge. The activated sludge pure oxygen system is accepted for further analysis as a secondary treatment option for the Deer Island treatment facility because of its widespread use and proven performance.

Burns-McDonnell Treatment System (BMTS)

Burns-McDonnell Treatment System (BMTS) is an activated sludge system with an intrachannel clarifier. BMTS was pilot tested at a 0.3-mgd plant in 1980. The largest unit in operation is at a 40-mgd plant in Missouri. Approximately 40 plants with an average flow of about 2 to 3 mgd are in the design, construction, or operational stage. Because of a lack of experience with large units, the manufacturer recommends that individual units do not exceed 10 mgd, with a depth up to 16 ft and a detention time of 10 hours. Using these criteria, 80 acres of land would be required at Deer Island. The BMTS is rejected as a secondary treatment option because it lacks statistically proven operational data and the costs are unknown at large wastewater treatment facilities. Furthermore, the acreage and spoils disposal required far exceeds the area and volume required for the reference process (air activated sludge and rectangular clarifiers).

Powdered Activated Carbon (PAC)

Powdered activated carbon is fed to the aeration tank of an activated sludge process. Carbon contained in the waste sludge is regenerated thermally. Powdered activated carbon lacks statistically proven operating history at large wastewater facilities. The first system manufactured by Zimpro was pilot tested in the mid 1970's. The largest facility, located in North Carolina, commenced operation in early 1980 and treats a flow of 12 mgd. For the MWRA project, a PAC system was sized with a detention time of 4.6 hours for aeration and average-day overflow rate of 360 gpd/ft$^2$ for secondary sedimentation. The analysis resulted in the determination that 60 acres of land would be needed at Deer Island. Powdered activated carbon

has not been used at very large plants and may be an operationally complex process. For these reasons, powdered activated carbon is rejected as a secondary treatment process.

Deep Shaft

The deep shaft system employs a vertical underground shaft to provide highly efficient oxygen transfer. The process lacks statistically proven operating history at large wastewater treatment facilities, and effluent quality is not well documented. The largest system, a 9.2-mgd plant in Canada, commenced operation in the early 1980s. This plant has two shafts which are 450 ft deep and 4.5 ft in diameter. The manufacturer (Deep Shaft Technology Inc.) recommends 10 shafts 40 ft by 40 ft in area and 300 ft deep for Deer Island. The ten shafts require 3 acres of land at the treatment facility. The deep shaft process is rejected as an option for secondary treatment because it lacks statistically proven operational data at large wastewater treatment facilities and could pose some construction difficulties.

Sequence Batch Reactor (SBR)

The sequence batch reactor is a method of activated sludge that uses one basin for biological degradation and solids separation. The SBR has not been used at large wastewater facilities. SBR is a relatively new process that is still being developed. Most full scale plants are in operation outside the United States. The largest unit in the United States treats a flow of 12 mgd. The SBR, sized at a detention time of 15 hours, requires 70 acres of land at the treatment facility. SBR is rejected as a secondary treatment alternative because it lacks proven success at large treatment facilities.

Rotating Biological Contactors (RBC)

Rotating biological contactors are employed in a fixed film process that has been used in the United States since 1969. RBCs are sized at a BOD loading of up to 6 lbs $BOD_5$ /day/1000 $ft^2$ of media. The rotating biological contactors are rejected as a secondary treatment option because they are not in widespread use at large wastewater treatment facilities. Also, the area required far exceeds that of the reference process (air activated sludge).

Trickling Filter, Plastic Media

Trickling filters have been in widespread use for the past 60-70 years. Units with plastic media have been used for about 20 years. Plastic media trickling filters sized at a BOD loading of 20 lbs/1000 $ft^3$ /day require 36 acres of land at the treatment facility. Trickling filters are rejected as a secondary treatment option because effluent quality is not as good as that produced by the activated sludge process, during cold weather. Furthermore, the area required far exceeds that of the reference process (air activated sludge).

Biological Filtration

Biological filtration is not in widespread use in the United States. Full-scale facilities (2

mgd) are in operation in Europe and the process has been pilot tested in other countries. Full-scale downflow facilities (Biodrof system) have been in operation since 1985 in Mannheim, West Germany. The plant treats 55 mgd of a poorly treated secondary effluent. BOD and suspended solids removal is reportedly 90 percent. Further pilot testing is underway in Canada and Switzerland. A biological filtration process sized at a rate of 1.3 gpm/$ft^2$ requires 7 acres of land at the treatment facility. Biological filtration is rejected as a secondary treatment option because it lacks statistically proven operating history at large wastewater treatment facilities.

Coupled Systems

Two types of coupled systems exist: (1) the coupled trickling filter-activated sludge process (TF/AS); and (2) the trickling filter-solids contact process (TF/SC).

The TF/AS process is designed so that the trickling filter serves as a roughing filter, and final effluent-quality soluble BOD removal is achieved in the aeration step. In the TF/SC process, the trickling filter is designed to achieve effluent-quality BOD removal and is followed by a short aeration period to enhance the settleability of the solids.

Comparatively, the TF/AS process has the lower capital cost and the TF/SC has the lower energy consumption. Due to area constraints, the TF/AS process was considered for the Deer Island treatment facility.

For the MWRA project, the trickling filter was sized at a BOD loading of 94 lbs/1000 $ft^3$ /day assuming 20-ft-deep units, and the activated sludge process was sized at a detention time of one hour. The two unit processes require 12 acres of land at the treatment facility. The coupled system is accepted as a secondary treatment alternative because it is a proven process and requires less power, maintenance, and acreage than the reference process (air activated sludge).

Pulsed Bed Filtration

Pulsed bed filtration is not in widespread use and full scale plants have small capacities. A system recommended by the manufacturer for the MWRA project consists of first and second stage filters sized at rates of 2 and 10 gpm/$ft^2$ respectively. The two-stage filters require approximately 6 acres of land at the treatment facility. However, the manufacturer's data shows that the process cannot remove soluble BOD to required levels. Pulsed bed filtration is rejected as a secondary treatment option because it cannot meet secondary treatment standards.

Physical-Chemical Treatment

Physical-chemical treatment has been used at small and large treatment facilities. Experience with physical-chemical treatment as an alternative to biological secondary treatment has shown that its higher initial costs and operational complexity are not normally justified unless wastewater quality or effluent requirements eliminate consideration of biological treatment.

The process, which includes primary sedimentation with chemical additions, filtration, and upflow activated carbon, requires approximately 25 acres of land at the treatment facility. Physical-chemical treatment is rejected as a secondary treatment option because the MWRA wastewater is amenable to biological treatment and the process is costly and complex.

Secondary Clarifier, Rectangular

Rectangular secondary clarifiers are in widespread use. The units have been used at many treatment facilities with flows in excess of 100 mgd. The units sized at an average-day overflow rate of 450 gpd/$ft^2$ require 35 acres of land at the treatment facility. Rectangular secondary clarifiers are accepted as a secondary treatment option because they are a proven and effective form of secondary clarification. Furthermore, rectangular clarifiers are land efficient, and land is at a premium at the facility.

Secondary Clarifier, Circular

Circular secondary clarifiers are in widespread use. The units have been used at wastewater treatment facilities with flows in excess of 100 mgd. They have advantages over rectangular units for secondary settling because sludge can be removed quickly and easily. The units, sized at an average-day overflow rate of 450 gpd/$ft^2$, require 56 acres of land at the treatment facility. Circular secondary clarifiers are rejected as a secondary treatment option because they require about 40 percent more area than rectangular units and are no more reliable than rectangular units.

Secondary Clarification (High Rate) Followed by Filtration or Microscreens

Secondary sedimentation followed by filtration, or microscreens, has been used at various activated sludge facilities in the United States. The processes evaluated consist of a secondary clarifier sized at 800 gpd/$ft^2$ and a multimedia filter sized at a rate of 5 gpm/$ft^2$, or a microscreen sized at a hydraulic loading rate of 6 gpm/$ft^2$. Either combination requires 22 acres of land at the treatment facility.

Both options have been rejected as treatment options because: (1) microscreening has difficulty in maintaining a consistent filtrate quality due to fluctuating influent loading and buildup of biological slime on the microfabric; and (2) filtration is a complex process with extensive operational and maintenance needs.

Tray Clarifiers

Tray systems are primarily used in the field of water treatment. The wastewater passes horizontally through one portion of the tank, then passes vertically for a second horizontal pass through the tank. The units sized at an overflow rate of 450 gpd/$ft^2$ require 20 acres of land. The system is rejected as a secondary treatment option because it lacks statistically proven operating history in municipal wastewater treatment.

Stacked Clarifiers

Stacked clarifiers are operated at a number of municipal wastewater treatment facilities in Japan. Wastewater is passed through only one compartment. There are two separate compartments per tank and they are very similar to conventional units. The units sized at an average day overflow rate of 450 gpd/ft$^2$ require 20 acres of land. Stacked rectangular clarifiers are accepted as a secondary treatment option because of their economy of land area. However, their construction may be more difficult compared to rectangular clarifiers.

Rotary Screens

Rotary screens have been used for further treatment of primary and secondary effluents. At the 350 mgd Los Angeles County Joint Water Pollution Control Plant, primary effluent is screened with six units that have 0.03-in screen openings. A portion of the primary effluent is discharged to the ocean without secondary treatment at this facility. At the 40 mgd Cedar Creek Water Pollution Control Plant in Nassau County, NY, secondary effluent is screened before discharge to the ocean. For this study, screening will be considered for any flows not receiving secondary treatment.

Evaluation Matrix

Tables 8.4.4-1 to 8.4.4-3 present the evaluation matrix for secondary treatment options including activated sludge processes, fixed film processes and other processes. Air activated sludge is the reference unit process to which the other unit processes are compared. Table 8.4.4-4 presents the evaluation matrix for secondary sedimentation processes. Circular secondary clarifiers constitute the reference unit process to which other unit process are compared.

## 8.4.5 DISINFECTION

Introduction

The purpose of this subsection is to present the preliminary evaluation and screening of disinfection alternatives. Disinfection of the plant's effluent is required in order to reduce the level of bacteria and pathogens present for protection of public health. The draft of the NPDES permit requires that disinfection reduce this level to an average monthly most probable number (MPN) of 200 fecal coliform bacteria in every 100 ml of effluent. This is commonly expressed as 200 MPN/100 ml. The Draft NPDES permit also sets a maximum daily limit of 400 fecal MPN/100ml.

The facility will be constructed in phases, with primary facilities constructed and in operation prior to the completion of secondary facilities. This impacts the evaluation of disinfection alternatives. Primary wastewater effluent is more difficult to treat and requires a greater amount of disinfectant than does secondary effluent, because of the higher levels of

**TABLE 8.4.4-1**

**EVALUATION MATRIX FOR SECONDARY TREATMENT UNIT PROCESSES (ACTIVATED SLUDGE)**

| | Air* | Oxygen | Burns-McDonnell Treatment System | Powdered Activated Carbon | Deep Shaft | Sequencing Batch Reactors |
|---|---|---|---|---|---|---|
| Reliability | average | average | low | average | low | low |
| Flexibility | average | high | low | high | average | low |
| Constructibility | normal | normal | difficult | normal | difficult | difficult |
| Safety | normal | special | normal | normal | normal | normal |
| Operators Req. | average | greater | fewer | greater | average | average |
| Operational Complexity | average | difficult | simple | difficult | difficult | difficult |
| Power Efficiency | average | average | average | low | average | average |
| Auxiliary Needs | none | standby oxygen | none | regenera-tion facility | none | none |
| Resid. Aspects | average | average | average | average | average | average |
| Spoils Disposal | average | average | difficult | average | difficult | average |
| Air Emissions Control | average | good | average | good | average | average |
| Noise | average | average | average | average | average | average |
| Aesthetics | average | average | average | average | good | average |
| Effluent Quality | average | average | average | average | limited data available | average |

*Reference unit process

**TABLE 8.4.4-2**

**EVALUATION MATRIX FOR SECONDARY TREATMENT UNIT PROCESSES (FIXED FILM PROCESSES)**

| | Rotating Biological | Trickling Filters | Biological Filtration |
|---|---|---|---|
| Reliability | low | average | low |
| Flexibility | low | average | average |
| Constructibility | average | average | average |
| Safety | normal | normal | normal |
| Operators Required | average | fewer | average |
| Operational Complexity | average | simple | average |
| Power Efficiency | low | high | high |
| Auxiliary Needs | none | pumping station | media makeup |
| Residuals Aspects | good | good | average |
| Spoils Disposal | average | average | average |
| Air Emissions Control | average | average | average |
| Noise | good | good | good |
| Aesthetics | good | average | average |
| Effective Quality | average | average | limited |

*Reference unit process is air activated sludge

**TABLE 8.4.4-3**

**EVALUATION MATRIX FOR SECONDARY TREATMENT UNIT PROCESSES (OTHER PROCESSES)**

| | Coupled System | Pulsed Bed Filtration | Physical Chemical Treatment |
|---|---|---|---|
| Reliability | average | low | average |
| Flexibility | average | average | low |
| Constructibility | normal | normal | normal |
| Safety | normal | normal | normal |
| Operators Required | average | average | greater |
| Operational Complexity | average | average | difficult |
| Power Efficiency | average | high | low |
| Auxiliary Needs | pumping station | air/water backwash | chem/fuel |
| Residuals Aspects | average | good | difficult |
| Spoils Disposal | average | average | average |
| Air Emissions Control | average | none | good |
| Noise | average | good | average |
| Aesthetics | average | good | average |
| Effluent Quality | average | low | average |

*Reference unit process is air activated sludge

TABLE 8.4.4-4

EVALUATION MATRIX FOR SECONDARY TREATMENT UNIT PROCESSES
(SEDIMENTATION PROCESSES)

| | Rectangular Tank | Circular Tank* | High Rate/ Filtr. or Microscreens | Tray Clarifiers | Stacked Clarifiers | Rotary Screens for Primary or Secondary Effluent |
|---|---|---|---|---|---|---|
| Reliability | average | average | high | no data | average | low |
| Flexibility | average | average | average | no data | average | low |
| Constructibility | normal | normal | normal | difficult | difficult | normal |
| Safety | normal | normal | normal | normal | normal | normal |
| Operators Req. | average | average | great | average | average | fewer |
| Oper. Complexity | average | average | difficult | average | average | difficult |
| Power Efficiency | average | average | average | average | average | low |
| Auxiliary Needs | none | none | chemical equipment | none | none | spray wash equipment |
| Resid. Aspects | average | average | average | average | average | good |
| Spoils Disposal | average | average | average | average | average | average |
| Air Emissions Control | average | average | average | average | average | none |
| Noise | average | average | average | average | average | average |
| Aesthetics | average | average | average | average | average | good |
| Effl. Quality | average | average | high | no data | average | high |

*Reference unit process is circular clarifiers

solids which inhibit effective disinfection. Therefore, disinfection alternatives are evaluated on their performance in disinfection of primary as well as secondary wastewater effluents. In addition to the disinfection of plant effluent, there are other elements of the facilities that may require the use of disinfectant chemicals. These are plant water (treated effluent), control of filamentatious growth in the aeration facilities by controlled dosing of the return activated sludge, and odor control facilities at selected locations.

Four unit processes were considered for disinfection at the treatment facility. Prime factors for accepting or rejecting the unit process include cost, reliability, safety, power requirements, and complexity. Below is a discussion of the unit processes in support of the recommendation to accept the process for, or reject it from, further evaluation as a treatment alternative at the Deer Island treatment facility.

Liquid Chlorine

Liquid chlorine is the benchmark against which other disinfection methods have historically been evaluated. Liquid chlorine is very reliable and has successfully met disinfection standards. Liquid chlorine is in widespread use at large wastewater treatment facilities. Some of these facilities include Metropolitan Seattle (125 mgd), Detroit (840 mgd), Hartford (60 mgd), and the existing MWRA treatment plants. However, many municipalities no longer use liquid chlorine because of safety concerns. Liquid chlorine can be toxic to humans if inhaled as a gas and thus the transportation, handling, and storage of the product must be done in accordance with regulations to minimize the threat to human health and the environment. During the facility siting process, the EPA's determination included a prohibition on the use of liquid chlorine unless no other suitable alternative for disinfection existed. Therefore, liquid chlorine has been dropped from further consideration as a treatment option at Deer Island.

Sodium Hypochlorite

Sodium hypochlorite has been used at a number of treatment facilities for disinfection of both primary and secondary wastewaters. Large wastewater facilities that use sodium hypochlorite include the New York City treatment facilities, Chicago plants, and locally, the Greater Lawrence treatment facility. The efficiency of sodium hypochlorite is excellent. The cost of purchased sodium hypochlorite is approximately twice that of liquid chlorine. For area sizing, a 15-minute contact time at peak flow was used, and the associated area for the treatment facility is 2 acres of land.

Sodium hypochlorite has been retained for further evaluation. There are two methods (barging and on-site generation) of furnishing sodium hypochlorite to Deer Island. Both will be evaluated during the detailed study.

Ozone

Ozone has been used as a disinfectant of drinking water for a number of years in Europe and its

use is increasing in this country. Its use for the disinfection of secondary effluent wastewater is not very common. It has been used for disinfection of tertiary wastewaters and it has been used for specific chemical wastewater polishing -- most notably with cyanide wastes. There is no available information on the use of ozone for disinfecting primary effluents. Successful disinfection requires that sufficient ozone be provided to meet and/or exceed the oxygen demands of both the biological constituents and chemical constituents. Ozonation systems require significant amounts of electricity and are complex and difficult to operate. If oxygen activated sludge is considered for secondary treatment, ozone will be considered for detailed analysis.

Ultraviolet Irradiation

Ultraviolet (UV) irradiation as a means of disinfection was essentially nonexistent 15 years ago. The EPA's Innovation and Assessment (I/A) program led to the rapid development of ultraviolet irradiation as an acceptable method of disinfection. There are treatment facilities as large as 50 mgd (Madison, Wisconsin) that use UV for disinfection. The systems installed to date have been designed for either secondary or tertiary effluent. The system's effectiveness is dependent upon the transmissivity of the effluent, and the strength and duration of the UV dosage applied. Ultraviolet irradiation systems require power for the lights. The contact time is typically 5 minutes or less. The system requires regular replacement of the UV bulbs in order to maintain performance. There is no evidence of negative impacts upon the receiving waters. Ultraviolet irradiation has been successfully used on 30/30 secondary effluents. It eliminates water quality impacts associated with clorinated compounds, and it occupies a much smaller area than chlorine contact facilities. It is therefore considered prudent to retain it as a disinfection option.

Evaluation Matrix

Table 8.4.5-1 presents the evaluation matrix for disinfection options. Liquid chlorine is the reference unit process to which the other unit processes are compared.

## 8.5 ALTERNATIVES RECOMMENDED FOR DETAILED EVALUATION

### 8.5.1 WASTEWATER TREATMENT ALTERNATIVES

Wastewater treatment facilities are combinations of unit processes. These unit processes may be generally categorized as preliminary treatment, primary treatment, secondary treatment, disinfection and residuals treatment and disposal. In this section, unit processes for the first four functional areas were evaluated and screened. Residuals management (sludge, scum, grit and screening treatment and disposal) is the subject of another facilities plan.

Table 8.5.1-1 summarizes the individual unit processes evaluated and identifies which unit processes are recommended for detailed evaluation. Unit processes recommended for further study have long-term operating history at major wastewater treatment facilities and generally satisfy other screening criteria.

**TABLE 8.4.5-1**

**EVALUATION MATRIX FOR DISINFECTION**

| | Liquid* Chlorine | Sodium hypochlorite (trucked) | Sodium hypochlorite (barged) | Sodium hypochlorite (on-site) | Ozone (air gen.) | Ozone (02 (gen.) | Ultra-violet |
|---|---|---|---|---|---|---|---|
| Reliability on primary effluent | average | average | average | average | low | low | low |
| Reliability on secondary effluent | average | average | average | average | low | low | average |
| Flexibility | high | high | high | high | low | low | average |
| Constructibility | average | average | average | average | average | average | average |
| Safety | special | normal | normal | normal | special | special | normal |
| Operators Required | average | fewer | few | greater | greater | greater | average |
| Operational Complexity | average | average | average | diffic. | diffic. | diffic. | simple |
| Power Efficiency | average | average | average | low | low | low | average |
| Auxiliary Needs | water supply | none | none | acid clean | none | oxygen supply | acid clean |
| Residuals Aspects | NA | NA | NA | by products | NA | NA | NA |
| Spoils Disposal | average | average | average | average | average | average | average |
| Air Emissions Control | none | none | none | none | average | average | none |

**TABLE 8.4.5-1**
**(Continued)**

**EVALUATION MATRIX FOR DISINFECTION**

| | Liquid* Chlorine | Sodium hypochlorite (trucked) | Sodium hypochlorite (barged) | Sodium hypochlorite (on-site) | Ozone (air gen.) | Ozone (02 (gen.) | Ultra-violet |
|---|---|---|---|---|---|---|---|
| Noise | good | good | good | good | diffic. | diffic. | good |
| Aesthetics | average | average | average | average | average | average | average |
| Effluent quality, primary effluent | average | average | average | average | low | low | low |
| Effluent quality, secondary effluent | average | average | average | average | low | low | average |

* Reference unit process

Table 8.5.1-1
SUMMARY OF UNIT PROCESSES EVALUATED

| Unit Processes Evaluated | Unit Processes Retained For Detailed Analysis |
|---|---|
| **PRELIMINARY TREATMENT** | |
| Climber Bar Screens | Climber Bar Screens |
| Catenary Bar Screens | Catenary Bar Screens |
| Horizontal Flow Grit Channel | |
| Aerated Grit Chamber | Aerated Grit Chamber |
| Centrifugal Grit Chamber | Centrifugal Grit Chamber |
| Cyclone Primary Sludge Degritting | |
| Preaeration | |
| **PRIMARY TREATMENT** | |
| Rectangular Clarifiers | Rectangular Clarifiers |
| Circular Clarifiers | |
| Sedimentation with Chemical Addition | |
| Tray Clarifiers | |
| Stacked Clarifiers | Stacked Clarifiers |
| Inclined Tube Settlers | |
| **SECONDARY TREATMENT** | |
| Air Activated Sludge | Air Activated Sludge |
| Oxygen Activated Sludge | Oxygen Activated Sludge |
| Burns-McDonnell Treatment System | |
| Powdered Activated Carbon | |
| Deep Shaft | |
| Sequencing Batch Reactor | |
| Rotating Biological Contactor | |
| Trickling Filter | |
| Biological filtration | |
| Coupled System | Coupled System |
| Pulsed-Bed Filtration | |
| Physical-Chemical Treatment | |
| Rectangular Clarifiers | Rectangular Clarifiers |
| Circular Clarifiers | |
| High Rate Clarifiers Followed by Filtration or Microscreens | |
| Tray Clarifiers | |

Table 8.5.1-1
SUMMARY OF UNIT PROCESSES EVALUATED
(continued)

| Unit Processes Evaluated | Unit Processes Retained For Detailed Analysis |
|---|---|
| Stacked Clarifiers | Stacked Clarifiers |
| Screening (for primary effluent) | Screening (for primary effluent) |
| **DISINFECTION** | |
| Liquid Chlorine<br>Sodium Hypochlorite | Sodium Hypochlorite (purchased and on-site or off-site generation) |
| Ozone | Ozone (only with oxygen activated sludge.) |
| Ultraviolet Irradiation | Ultraviolet Irradiation |

## 8.5.2 HYDRAULIC ALTERNATIVES

Several major decisions have preceded this study. The new wastewater treatment facility will treat flows from the existing service area at a single facility to be located at Deer Island. The existing Nut Island treatment facility will be decommissioned and South System flows conveyed to Deer Island. After treatment at Deer Island, plant effluent will be discharged through a new outfall. These decisions limit the number of possible alternatives.

Two broad alternatives emerge, with many possible subalternatives or combinations. The two alternatives are differentiated primarily by hydraulics. All flow reaching Deer Island must be pumped into the treatment facilities. The wastewater flows through the plant by gravity until it reaches the outfall. Depending on the elevation of the plant, the outfall length and the tidal conditions, the treated wastewater may flow through the outfall by gravity to disposal. Under other conditions, the wastewater effluent must be pumped through the outfall.

In Alternative I (Figure 8.5.2-1) the influent pumps raise the wastewater to a sufficient elevation so that it may flow by gravity to the end of the plant. The pumps in the existing Main Pump Station would have to be modified to provide this additional lift. In Alternative II (Figure 8.5.2-2), the influent pumps only raise the wastewater a sufficient height to flow by gravity through preliminary and primary treatment. These facilities would remain at the same hydraulic grade as the existing Deer Island facilities. The pumps at the Main Pump Station would not require modification under this alternative. Wastewater would require intermediate pumping prior to secondary treatment. For both alternatives, gravity flow through the outfall would depend on the conditions noted above.

For Alternative II, the new South System pumping station at Deer Island could be designed in one of two ways. As shown on Figure 8.5.2-2, the South System flows could be transported directly to primary treatment facilities that also serve the North System, or South System flows could be directed to separate primary treatment facilities which would operate under a higher hydraulic gradeline than the corresponding North System facilities. Under this alternative, South System primary treatment units would be constructed to allow South System flow by gravity to combined secondary treatment.

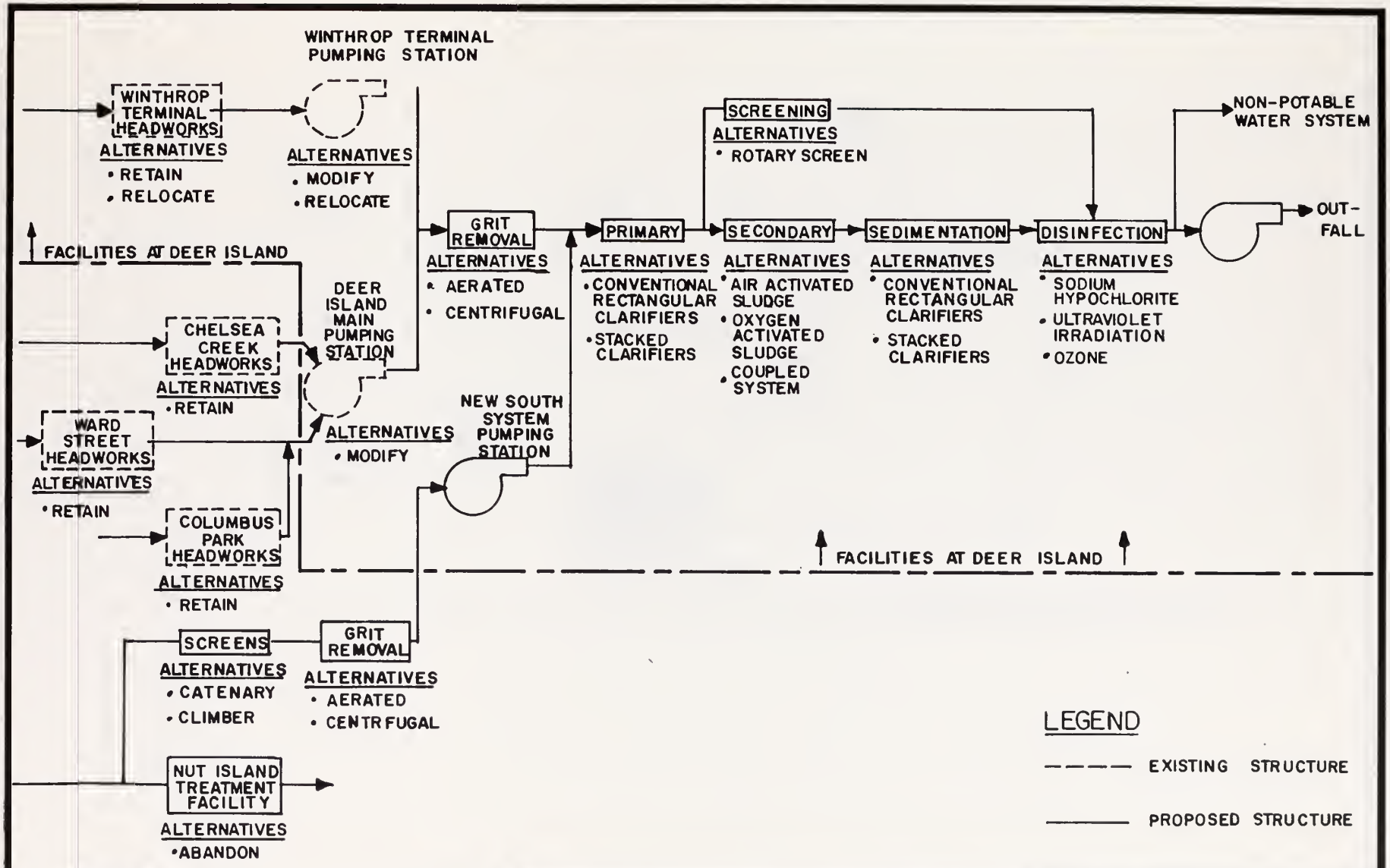


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**FIGURE 8.5.2-1**
**ALTERNATIVES SELECTED FOR DETAILED ANALYSIS**
**(ALTERNATIVE I)**

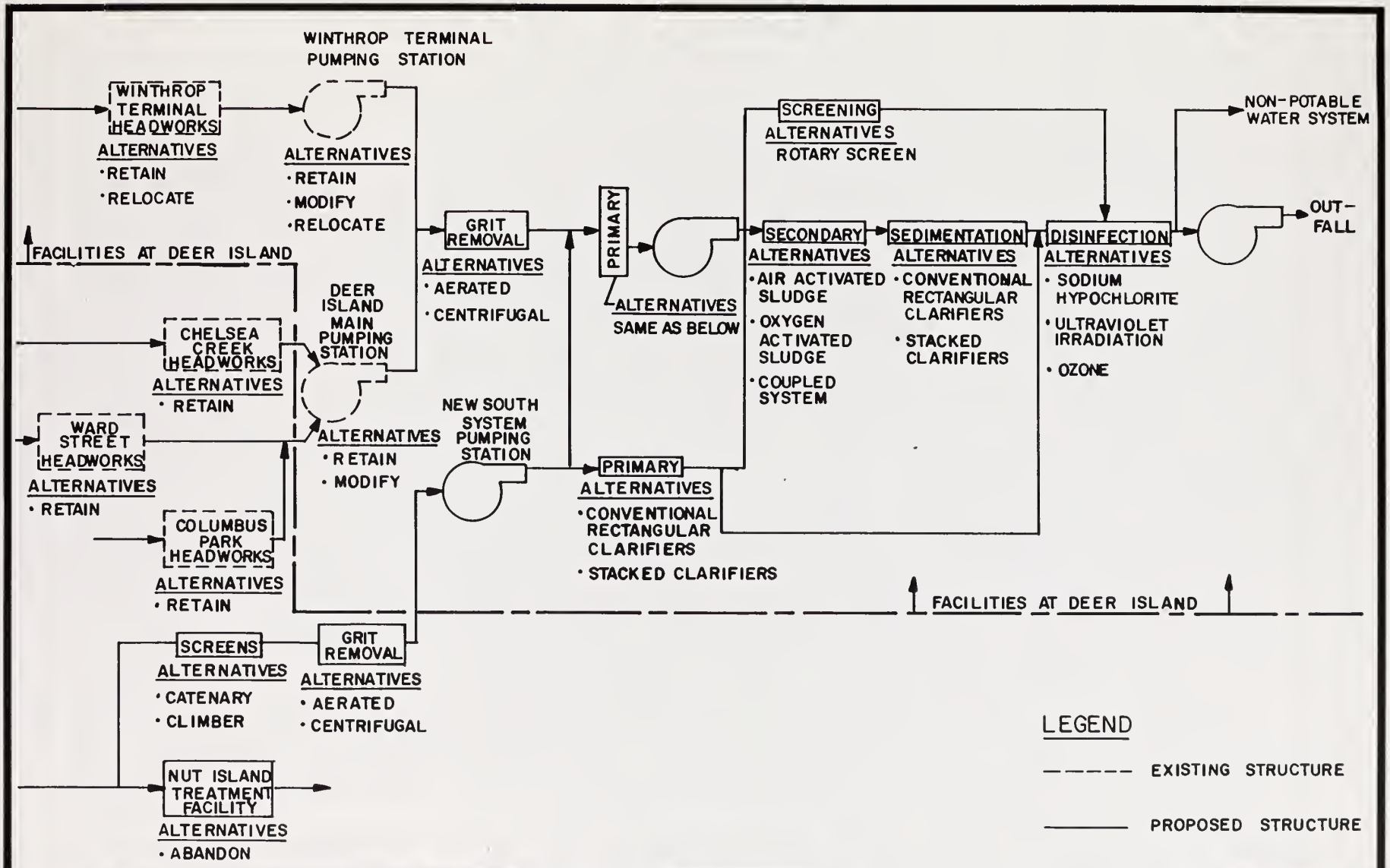


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FIGURE 8.5.2-2
ALTERNATIVES SELECTED FOR DETAILED ANALYSIS
(ALTERNATIVE II)

# Section 9

# 9.0 ALTERNATIVE SITE PLANNING

## 9.1 INTRODUCTION TO SITE PLANNING ALTERNATIVES

The site planning process for the Deer Island Secondary Treatment Facilities involves two principal sites: the Deer Island site, to be utilized for the secondary treatment facilities, and the Nut Island site containing the existing plant which is to be decommissioned and replaced by a headworks structure. The challenge of planning the facilities for these two sites involves identifying and responding to the many varied elements that impact the sites, while at the same time defining and locating operable and reliable facilities that can be constructed within the allotted timeframe.

This facilities plan was preceded by a site selection process that identified the best available site for the treatment facilities. The selected sites have finite boundaries; therefore, the recommended facilities must fit within the selected sites.

The Deer Island site is approximately 200 acres in size, measured from the Winthrop town line to the mean high water line. The site is encircled by water, and State and Federal Permit programs preclude the option of creating additional land by filling below the mean high water line. Fortunately, there is a sizeable area of Deer Island that is presently unused, thereby affording the development of site plans that allow for the staging of the construction.

The Nut Island site is also surrounded by water, and filling of the adjacent Quincy Bay is forbidden by State Law. The Nut Island Site is constrained by its small size and nearly total present usage as a treatment plant site. The site planning process must identify which elements of the existing plant will remain in service during construction and which elements will be decommissioned.

The defined horizontal boundary of the sites requires that the site planning process evaluate means of clustering project elements together. Use of the vertical plane, either placing elements above or below each other, is the only unconstrained direction available to the site planner.

During the compilation of this study the site planning process has proceeded through three steps. The first step was to evaluate the relationship of the sites to the abutting communities and to the adjacent harbor. From that definition, development concepts were evaluated for their social and environmental impact, and favorable concepts were carried forward as a template for the subsequent planning steps. This step was referred to as Harbor Perspective and is the subject of Section 9.2.

The second step in the site planning process was an integration of the process alternative evaluations and the specific site conditions. For each of the various elements of the process, from grit removal facilities through disinfection facilities, a detailed engineering evaluation was conducted. The assemblage of these process alternatives is the subject of Section 9.3.

The principle conclusion for the Deer Island site was that the use of stacked primary and secondary rectangular clarifiers produced significant and necessary land savings. A second conclusion was that the plant's elevation should be raised to approximately 150 ft at the primary treatment facilities to minimize excavation and to optimize plant hydraulics.

The final step of the site planning process is presented in Section 11.1 as the recommended plan. All of the various elements are assembled as a cohesive organizational unit. The recommendation for the treatment process, along with the recommendations for power facilities, operational organization, site access, and construction sequencing, are incorporated into the recommended plan.

## 9.2 HARBOR PERSPECTIVE - ALTERNATIVE PLANNING CONCEPTS

### 9.2.1 CONTEXT OF HARBOR PERSPECTIVE

This section on Harbor Perspective was originally presented as a technical memorandum in November of 1986. It was the first document prepared that addressed the issues of site development and site planning concepts.

The Harbor Perspective document presented a number of concepts for both Deer Island and Nut Island site development. Those concepts were presented to the public, the regulatory agencies, and the Authority's staff. A consensus was reached that the sites should be developed to optimize the natural rather than the technological image of the sites.

The November, 1986 technical memorandum consisted of three sections: an introduction, a background definition, and the alternative planning concepts. The third section, the alternative planning concepts, is presented in this section. It should be noted that when the memorandum was originally written, many of the site's elements, such as pier facilities, were in various stages of planning. Accordingly, the text reflects all available information as of November 1986. Editorial revisions have been made as necessary for consistency with the overall format of this report.

### 9.2.2 HARBOR PERSPECTIVE LAND USE EVALUATION - DEER ISLAND CONCEPTS

#### Introduction

A number of land use ideas were identified for Deer Island. From this identification process, four concepts were selected for their relative merits, to be studied on a conceptual basis in greater detail.

From the number of land use ideas that were identified but rejected, one concept might be discussed to illustrate the wide range of ideas considered. A concept that would retain the central drumlin was identified. This concept necessitated the splitting of the treatment facilities into two sections and their placement on either side of the drumlin, and the filling of land in the northern section of the island to accommodate the areas needed for secondary clarifiers. This concept was not considered feasible, due to both engineering and mitigation concerns. It was, therefore, not selected for further study.

Of the four concepts selected, two are based upon options that make the new plant a prominent feature of the harbor and two on options that minimize the visual impact of the plant. Concepts I and IV represent the polar opposite approaches. Concept I removes the drumlins from the site entirely, creating a flat, level region offering the largest available area for construction of the treatment facilities and exposing the plant to view. Concept IV retains the excavations from the drumlins and creates a perimeter ring of undulating and landscaped forms that hide the plant from view. Concepts II and III are variants between these two poles.

Common Elements

There are common elements in all four concepts. These are discussed below, and are followed by a description of the unique features of each concept and an evaluation of the particular advantages and disadvantages of each concept.

Central Drumlin

All four concepts are based upon the removal of the existing central drumlin. This is necessitated by engineering and site planning concerns. Based upon engineering assumptions to date, the provision of a contiguous area of approximately 110 to 120 acres for the main treatment processes is a technical requirement of treatment facilities design and layout. (The remaining acreage is required for other plant functions and site development needs.) Mitigation and general site planning considerations require the establishment of a buffer zone around the plant separating the facilities from the water's edge and abutting communities. These two combined constraints motivate the leveling of the central drumlin from elevation 207 ft to a lower elevation. The amount of soil made available by the excavation of all drumlins and existing grades to elevation 125 ft is approximately 3 million cubic yards.

Pier Facilities Zone

The MWRA is conducting a separate study to evaluate alternatives for the piers. The MWRA has received a draft report on pier options, and that draft recommends a combined pier and bulkhead. These pier facilities have been shown on the plans as Zone 5. It is anticipated that the completed facility may require truck access to and from the residuals zone and the piers on a regular, daily basis. The exact pier configuration and size will be determined by the MWRA, based upon the pier study, at a subsequent date.

Treatment Facilities Zones

The same conceptual treatment process layouts have been used for all concepts in order to simplify their overall evaluation, thus resulting in similar zoning plans. Within the conceptual layouts, the zoning areas 1 and 3 have been considered interchangeable. There are also minor variations in the placement of the administration zone within each of the layouts.

The effects of alternative engineering options for the treatment facilities are discussed in Section 9.3 of the facilities plan.

Within the zones of the conceptual layouts as presented, it is indicated that the existing main pump station will remain at Deer Island. There will be other buildings included in the final plan. The exact number, size and height of those buildings is not yet known. For reference purposes, the reader may assume that such buildings could be similar in size to the existing main pump station building.

The areas shown as available for the four zones in the four alternative concepts range from 115 acres in Alternative I to 107 acres in Alternative IV. The larger area is similar to that shown in the FEIR.

- Zone 1: The area for primary treatment has been shown in the central portion of the island. This location would allow the facility to be placed naturally on the highest level of the island, formerly occupied by the central drumlin. If the hydraulic concept of gravity flow commencing from the primary treatment basins is used, then this would be an ideal position for this facility, because it would easily allow for an overflow weir from the effluent of the primary tanks to be set to an elevation of 135 ft, and would reduce the volume of basin excavation. This position would also situate the primary facilities further away from Point Shirley, while permitting their construction during a period when the existing primary treatment facilities would still be operational.

- Zone 2: The area for aeration and secondary sedimentation is situated at approximate levels of 128 ft and 120 ft respectively, in the general area of the existing prison and the existing treatment plant. It would allow Zone 2 to retain a hydraulic linkage with Zone 1. It is anticipated that the existing main pump station will be retained in the new facilities.

- Zone 3: The area for residuals is located at the southernmost end of the site and adjacent to the pier facilities. The area allocated is based upon the FEIR layouts. The Residuals Management Facilities Plan (RMFP), which is being conducted concurrently with this facilities plan, will evaluate the extent of sludge handling and processing on-site and will subsequently establish the required area for Zone 3. As the natural elevation of this site is about 116 ft, flood protection strategies -- either elevation of this zone, protection by dikes, or a combination of these measures -- will be required. Zones 3 and 1 are, however, considered at this time to be interchangeable. These areas may be switched or blended together as further engineering studies proceed and after alternative hydraulic options are studied and tested.

- Zone 4: The area for administration is shown to be at an approximate elevation of 140 ft in all concepts. This raised position allows an overview of all the plant areas and a dramatic view of Boston Harbor. The horizontal disposition of this zone in the various options is shown differently to indicate that a great degree of flexibility exists in the positioning of this activity. The disadvantages and advantages of each location will be discussed when evaluating each concept in the following sections. During the subsequent development of detailed layouts, the final location of administration facilities will be determined.

Historic Buildings and Archaeology

Three buildings (old pumping station, Hill Prison, and the prison superintendent's residence) may be eligible for nomination to the National Register of Historic Places and have been shown on all plans. Consideration has been given to their future use in the plans for Deer Island. (A fourth building, the farmhouse south of the old pumping station, is also designated, but appears to be either outside or on the perimeter of the STFP area.)

Based on a preliminary site visit, the old pumping station appears to be a good candidate for preservation and reuse. It has some admirable architectural features and its brick skin and metal roof structure could well provide a structure for future public usage. Logistically, its location is close enough to the pier to allow public water access without being in the way of the truck traffic to the pier. If the MWRA and related decision makers decide that the public educational/recreational program for Deer Island is feasible and compatible with the needs and constraints of a treatment facility, then this facility might be a good candidate for a public information center, cafeteria, and rest stop.

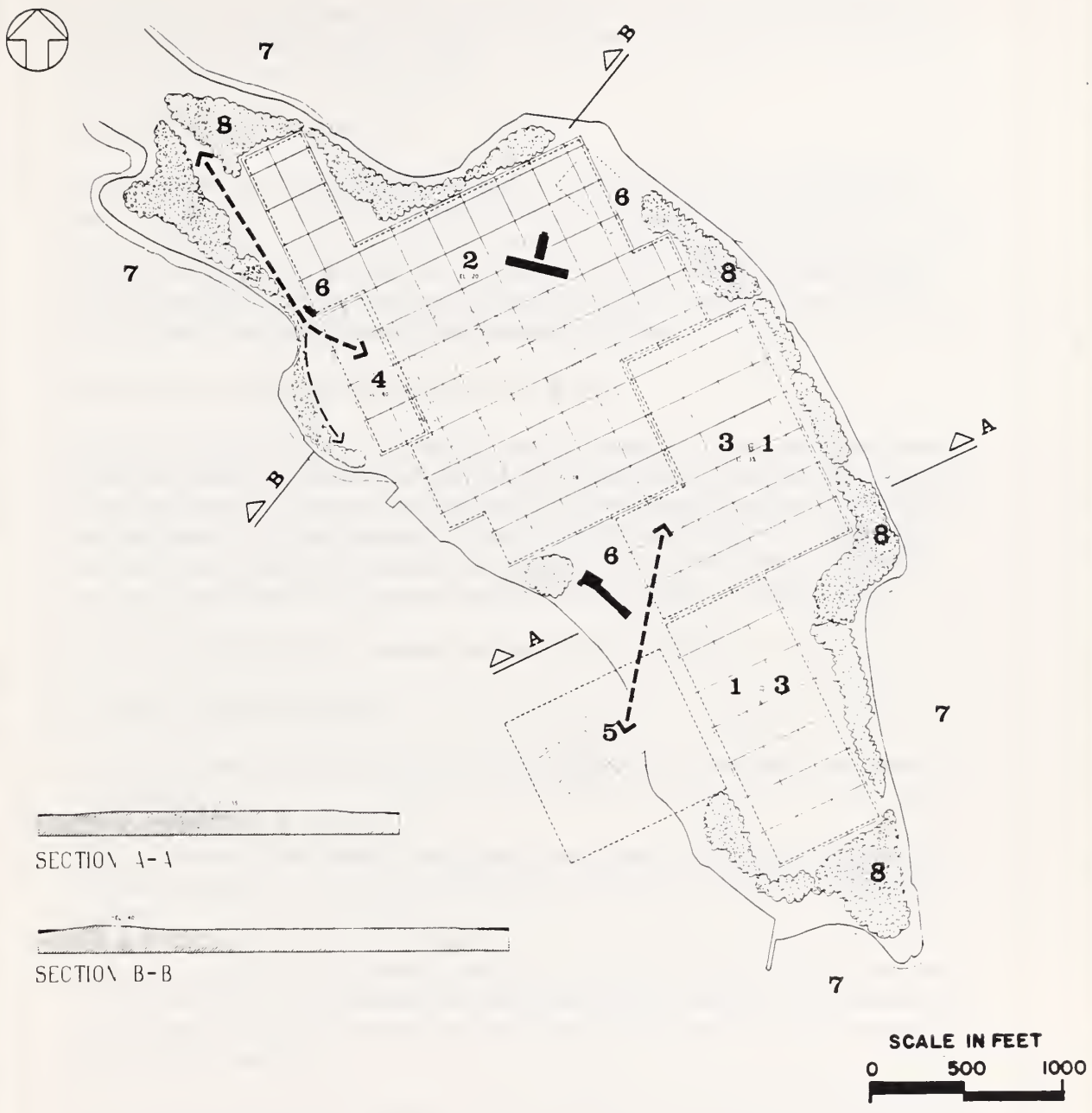
The superintendent's residence is a modest sized, neo-colonial brick structure that could be relocated and preserved in a suitable zone of the island. Zone 4 administration might reuse this facility both functionally and aesthetically. The historic building could "seed" the design of the new architecture of the proposed facilities in this zone.

The Hill Prison, in both vertical and horizontal location, poses a problem of another magnitude. Preliminary hydraulic and construction sequencing considerations place the preferred zone for the secondary clarifiers in the area presently occupied by the prison compound, at an elevation of approximately 120 ft. The Hill Prison presently is situated at an approximate elevation of 135 ft. To preserve the Hill Prison would likely mean the acceptance of an isolated, raised parcel of land atop which would sit the prison amidst the basins of the treatment plant. While this might be achieved technically, the doubtful functional use of such a building location, the "surrealistic" visual image of this floating prison, and the likely inefficiency of the process flow have resulted in the elimination of the prison from these analyses.

Located on the northeast corner of the island is a cemetery site. The graves are unmarked, except for one monument, and the full nature, extent, and age of the cemetery are unknown at this time. The general area has been indicated as part of Zone 6 in each of the subsequent figures, by means of a dashed line.

Deer Island Concept 1 - "The Level Concept"

This concept, shown in Figure 9.2.2-1, would reuse, to the minimum extent, the excavated soil from the drumlins and the basin excavations on-site. Approximately one million cubic yards of the nearly 4 million cubic yards available could be used on the site. The remaining 3 million




Legend

- Vehicular Access
- Existing Treatment Plant Structures
- Historic Buildings
- Mean High Water Level 110.6
- New Berms
- Usable Area: 115 Acres ±
- Trees & Shrubs
- 1 Primary Treatment Zone
- 2 Secondary Treatment Zone
- 3 Sludge/Storage Zone
- 4 Admin./Maintenance Operations Zone
- 5 Water Access Zone
- 6 Potential Historic Preservation Zone
- 7 Public Recreation Zone
- 8 Buffer Zone

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**FIGURE 9.2.2-1**
**DEER ISLAND HARBOR PERSPECTIVE**
**ALTERNATE CONCEPT I**

cubic yards would be disposed of off-site. The concept is to create a nearly flat plane. This would provide the largest possible "footprint" for the treatment facilities, and would make the plant a prominent feature of Boston Harbor.

Buffer and Public Recreation Zones

The perimeter of the island would be dedicated to a buffer zone (8) and a zone of passive, public recreation (7). Trees and shrubs would be used to separate the treatment plant from the activities at the water's edge. At key areas the trees are parted to allow views of key technological parts of the treatment plant. Within this buffer zone, the old pumping station could be designated for public use, should detailed planning indicate the compatibility of this use with other island activities and MWRA planning decisions.

The pier facilities zone is shown as number 5 in the plan.

Treatment facilities Zones 1 to 4 would measure approximately 115 acres and are also shown. This option would place Zone 4 administration at the southwest shoreline near the middle point of the site's shoreline. From this location, the administration zone would have an overview of the entire plant, be in close proximity to Point Shirley and the vehicular access to the site, and also be near the old pumping station and pier facilities. In this location the buildings with the greatest degree of architectural potential would be situated near Boston Harbor.

The historic buildings and the cemetery location are shown as Zone 6.

Preliminary Impact Observations

The impact of this concept with regard to social, technical, and environmental considerations is as follows:

Social. While the "level concept" might place a visible piece of technology, both innovative and soundly engineered, in full view of Boston Harbor, there are several adverse community impacts.

Temporary buffers would be necessary; otherwise, construction activities would be conducted in full view and within hearing distance of abutting communities. Removal of the increased volume of excavation from the island would cause more barge and truck traffic, which in turn would affect safety and security.

Due to the lack of any major landforms or other vertical screens, treatment plant noise would not be muffled immediately, but could be reduced by the growth of a screen of trees and shrubs in the far future. The immediate impact might be adverse.

Although more area on a flat terrain would be allowed in this scheme, recreational opportunities would always be compromised, due to their immediate visual association with the treatment plant. The technological image of the plant would be emphasized, while the recreational, scenic image of the island would be lessened. Additionally, this option may be

least able to create climatically comfortable outdoor micro-environments where vegetation could grow in abundance and survive the wind-swept, flat terrain.

The scenic quality of the island and its co-existence with the community would deteriorate; its historical image would also be lost. The preservation of historical/archaeological places would be possible, however.

Technical. This concept offers a distinct technical advantage in that it would provide the largest footprint for the treatment facilities.

Modification of the systems to support operational changes or provide greater flexibility, if ever required, into flat adjacent areas would be most readily available with this option.

This design would be built to a general elevation of 125 ft, which is above the mean high flood level.

Approximately 3 million cubic yards of earth would have to be disposed of off the island. Of the four concepts this would require the largest staging areas near the piers, largest truck traffic on the island during construction, largest barge loading pier facilities, greatest barge traffic in the harbor, and would necessitate the identification of feasible disposal sites.

Environmental. The proposed buffer and recreational zones included in this concept would depend heavily upon the growth and survival of trees and shrubs to screen the plant from public areas, and to provide micro-climates that are within comfort conditions for human usage. As these areas are manmade, flat terrains with minimum landforms, they would be exposed to winds, and, unless constructabove elevation 117 ft, would be subjected to high storm surges and wave action. The desired vegetation would not successfully acclimate or survive in these conditions.

As a corollary to the above observations, the administration and operations buildings of the plant would be designed as internalized, self-contained structures, as the outdoor environment may, in many instances, be too wind-swept for comfort.

As the environmental conditions for the support of wildlife may be questionable and at best precarious, the variety of wildlife that could inhabit the island would be limited.

Deer Island Concept II - "Single Mound Concept"

This concept, shown in Figure 9.2.2-2, is similar to Level Concept I. yet it achieves its distinction by placing a large landform on the northerly side of the island, which partly screens Point Shirley from the treatment facilities. Approximately 2 million cubic yards of the nearly 4 million cubic yards available could be used on the site.

The concept provides for approximately 112 acres of treatment facilities. and is based upon the idea of making the plant a prominent feature of Boston Harbor. yet also providing a screen for the Winthrop side.

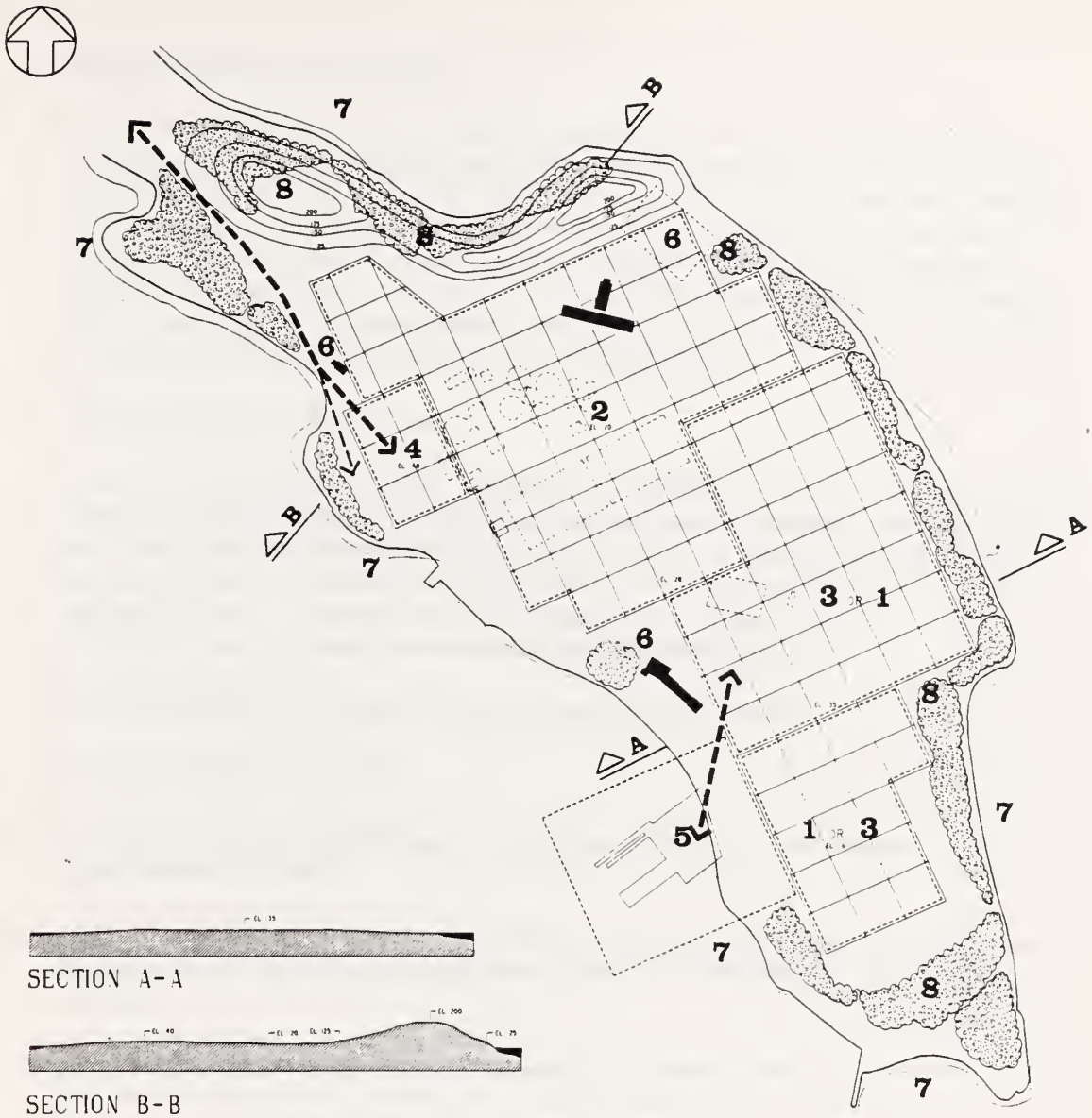


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**FIGURE 9.2.2-2**
**DEER ISLAND HARBOR PERSPECTIVE**
**ALTERNATE CONCEPT II**

Buffer and Public Recreation Zones

The perimeter of the island would be dedicated to a buffer zone (8) and a zone of passive, public recreation (7). The northern buffer zone would be created by an earthen berm rising to 210 ft (approximately 100 ft above the ocean), which would be planted. Trees and shrubs would be contained in the remaining buffer zones, which would be at grade level with the treatment facilities. At specific areas, the trees would be parted to allow views of key technological parts of the treatment plant. A new public use for the old pumping house could be designated within these buffer zones, should detailed planning indicate the compatibility of this use with other island activities and with other MWRA planning decisions.

The pier facilities are shown as Zone 5.

Treatment Facilities Zones 1 and 4 would measure approximately 112 acres. This concept would place Zone 4 administration nearly one-third of the way down the southwest shoreline. From this location, the administration zone could have an overview of the entire plant, be in close proximity to the vehicular access from Point Shirley, and be near the old pumping station and pier facilities zone. In this position, the buildings with the greatest degree of architectural design potential would be situated near Boston Harbor.

Historic buildings and the location of the cemetery are shown as Zone 6.

Preliminary Impact Observations

The impact of this concept with regard to the social, technical, and environmental considerations is as follows:

Social. While the "single mound" concept would screen parts of Winthrop from the treatment facilities, this concept is based upon the idea of prominently displaying the plant to Boston Harbor.

Construction activities would be partially screened from abutting Point Shirley, but within full view of Boston Harbor. Removal of two million cubic yards of excavated earth cut from the island could cause significant barge and on-shore truck traffic.

Plant noise reaching Point Shirley could be mitigated in part by the proposed mound, especially if heavily planted with trees and shrubs.

Recreational opportunities in Concept II would be compromised to approximately the same extent that they would be compromised under Concept I, with the exception of the northern mound/park separating Point Shirley and the treatment facilities.

The scenic quality of the island would generally deteriorate. While an acceptable transition to the abutting community character might be provided by the northerly "manmade drumlin," the historical image of the harbor islands would be lost and the context for preservation of historical/archaeological places would be diminished.

There would be a limited ability to create a comfortable, outdoor micro-environment that would be conducive to vegetative growth on the flat, wind-swept portion of the island.

Technical. This alternative would provide the next-to-largest footprint for the treatment facilities, which is an advantage.

Modification of the systems to support operational changes or to provide greater flexibility, if ever required, into flat adjacent areas would be readily available in this option.

This design would be built to a general level of 125 ft, which is above the mean high flood level.

Approximately 2 million cubic yards of earth would have to be disposed of off the island. Of the four concepts, this would necessitate the second-largest staging areas for trucks near the piers, and large barge loading pier facilities. It would also create the second-largest increased barge traffic in the harbor, and would necessitate the identification of feasible disposal sites.

Environmental. The proposed buffer and recreation areas of this concept would depend heavily upon the growth and survival of trees and shrubs, to both screen the plant from public areas and to provide micro-climates that are within comfort conditions for human usage. Except for the proposed landform zone on the northerly side of the island, the rest of the man-made, flat terrain would have minimum landforms. Because these latter areas would be exposed to wind, they would need to be constructed above elevation 117 ft to protect against high storm surges and wave action. It is doubtful that the desired vegetation would successfully survive in these conditions under normal maintenance procedures.

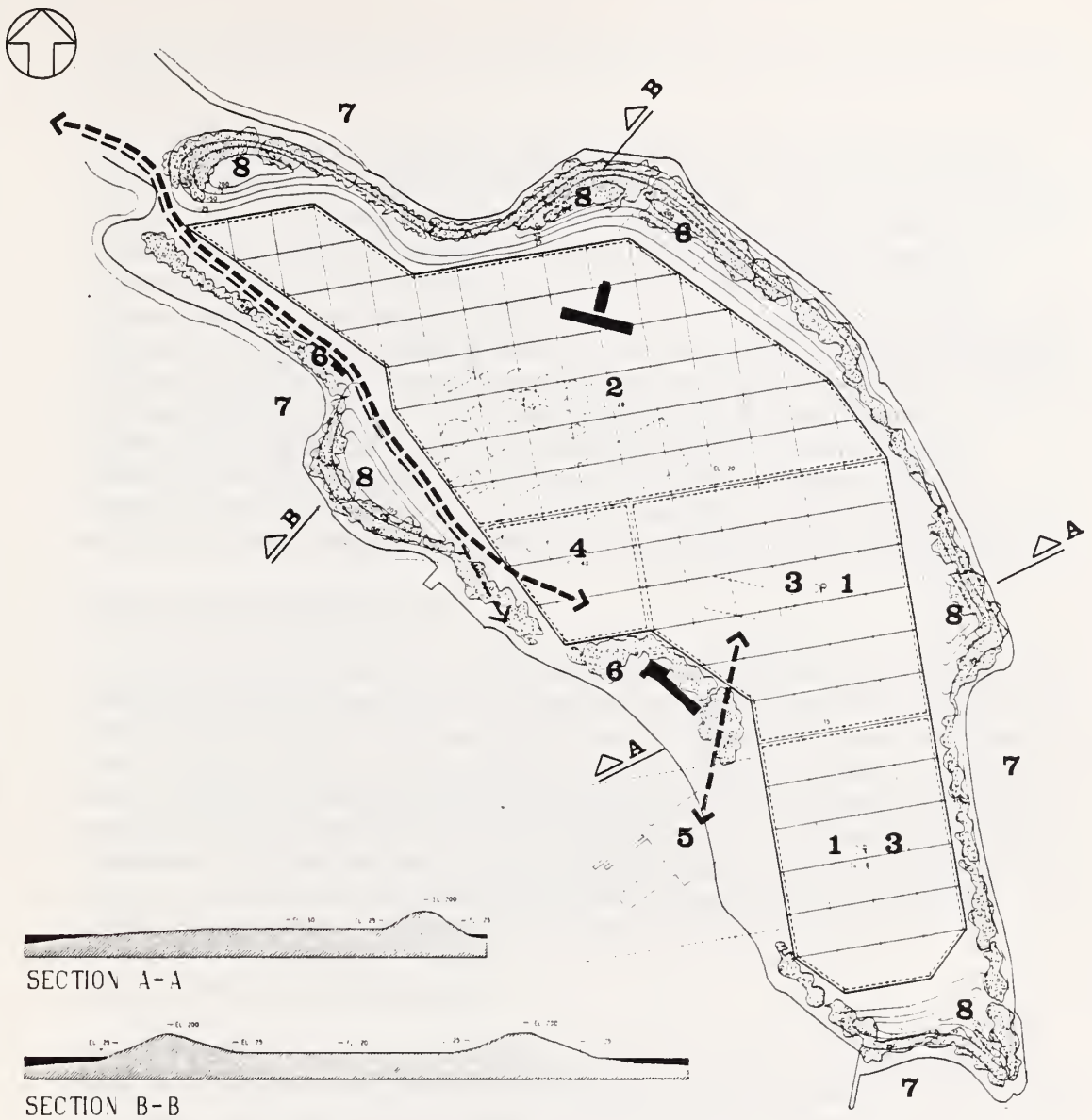
As a corollary to the above observations, the administration and operations buildings of the plant would be somewhat protected from the elements by the proposed landforms, but not as adequately as in Concepts III and IV. The buildings in this zone would have minimum outdoor environments conducive to comfort conditions, and would have to be designed as internalized, self-contained structures.

Since the environmental conditions for the support of wildlife might be questionable, except in the northerly zone of the proposed landforms, the variety and extent of wildlife that could inhabit the island would be limited.

Deer Island III - "The Necklace Concept"

This concept, shown in Figure 9.2.2-3, is similar to Concept IV and would reuse a substantial amount of the excavated soil from the drumlins and the basin excavations on-island.

Approximately three million cubic yards of earth would be placed in a series of manmade drumlins on the perimeter of the island site. The landforms would be forested and landscaped. By these means, the visual impact of the new plant upon the harbor and the adjacent communities would be reduced.




**Legend**

- Vehicular Access
- Existing Treatment Plant Structures
- Historic Buildings
- Mean High Water Level 110.6
- New Berms
- Usable Area: 108 Acres ±
- Trees & Shrubs
- 1 Primary Treatment Zone
- 2 Secondary Treatment Zone
- 3 Sludge/Storage Zone
- 4 Admin./Maintenance Operations Zone
- 5 Water Access Zone
- 6 Potential Historic Preservation Zone
- 7 Public Recreation Zone
- 8 Buffer Zone

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 9.2.2-3**
**DEER ISLAND HARBOR PERSPECTIVE**
**ALTERNATE CONCEPT III**

Landforms

The excavated soil would be placed at approximately elevation 140 ft around the northern, eastern, and southern portions of the island, leaving the western shoreline more open to Boston Harbor. A single, manmade mound rising from the western shoreline to elevation 210 ft is proposed, which would create a visual accent and would partially screen the plant from Winthrop. From the level of the basic berm that surrounds three-quarters of the site, apparently random higher peaks would rise to levels of 210 ft and 220 ft. These higher levels would match the height of the existing central drumlins and coincide with the general height of the other drumlins in Boston Harbor. The placement of these higher peaks would, however, be rigorously calculated to fit into available sites on the island, and to serve the specific purpose of screening particular views into the plant from adjacent landmark viewpoints. Therefore, a series of high ridges would be placed at the northern edge of the island, partially screening the Winthrop views. Another series of peaks would surround the southern edge and the residuals treatment area contained therein, to screen the view from Long Island.

Buffer and Public Recreation Zones

The man-made drumlins would serve as a three-dimensional buffer zone in this concept. The outer slopes, toward the water and the communities, are proposed to be heavily planted with shrubs and trees as shown. This outer zone (Areas 7 and 8) would continue uninterrupted to the water's edge, and would be primarily dedicated to passive, public recreational uses. In this zone, a perimeter path that the public may be allowed to use could be located, affording views around the harbor and dramatic views into the plant area, if future site planning studies so recommend. Bike trails, footpaths, and scenic lookouts could be planned in these zones for the public. A new use for the old pumping station could be designated in this zone, should detailed planning indicate the compatibility of this use with other island activity.

The pier facilities are shown as Zone 5.

Treatment facilities Zones 1 to 4 would measure approximately 108 acres. This option would place Zone 4 administration on the southwest shoreline at nearly mid-point of the island. From this location, the administration zone would have an overview of the entire plant, be closest to the old pumping station and pier facilities, yet still have access along a shoreline drive from Point Shirley. In this position, as with the other concepts, the buildings with the greatest degree of architectural design potential would be situated near Boston Harbor. This location also suggests a greater water access potential for this zone than for other locations considered.

Historic buildings and the location of the cemetery are shown as Zone 6.

Preliminary Impact Observations

The impact of this concept with regard to the social, technical, and environmental considerations is as follows:

Social. The "necklace concept" is based upon minimizing the impact of the plant upon Boston Harbor and the adjacent communities, but not entirely eliminating the plant from view.

As part of the first phase of construction, provided the land was available, adequate amounts of excess earth could be moved to the northerly side of the island to screen Winthrop from the view and noise of the plant. If this manmade drumlin is subsequently well-landscaped, and the Point Shirley side dedicated to a recreational park, the impact of the ensuing years of construction activity on the remaining portions of the island could be partially mitigated.

Plant noise and odor could potentially be reduced via the proposed landforms and landscaping.

The scheme proposed for the island in this concept would have a hidden portion (the plant), and a visible, manifest buffer zone. The manifest buffer zone could be developed and dedicated to passive, public recreation, particularly for the neighboring community. The recreational environment of the perimeter of the island could be left as a "wilderness isle." The proposed landforms on the Boston Harbor side of the island could create climatically comfortable micro-environments for public recreation.

The scenic quality of the island would be greatly enhanced, while the historical image of post-glacial drumlins, which create an appropriate context for historical buildings, could be preserved.

Technical. The area available for the footprint of the treatment facilities Zones 1-4 would be less than the area available in Concepts I and II. Should additional area be necessary, the newly created drumlins would need to be eliminated or leveled.

A limited amount of additional area for modification of the processes, if required, would be available in this option in the flat, adjacent areas to the west of the site.

This concept would build the inner areas of the treatment facilities to a general level of 125 ft, which is well above the flood level.

Approximately one million cubic yards of earth excavation would have to be removed from the site. This concept would necessitate on-loading pier facilities, off-island disposal barging, and the identification of feasible disposal sites.

Environmental. Most of the proposed buffer and recreational zones of this concept would be able to support the growth and survival of trees and shrubs due to the protective environments provided by the proposed landforms. Micro-climates toward the Boston Harbor side of the island, however, would not be fully shielded from the wind. and comfort conditions for human usage might be compromised in these zones.

The administration and operations buildings of the plant could be placed in semi-protected micro-environments conducive to placemaking and site planning designs that integrate the outdoors and the indoors.

The palette of wildlife on the island could be diverse, and the conditions for wildlife survival would be the second-best of the four concepts.

The proposed landforms could almost completely enclose the plant. The landforms may impact air circulation patterns over and within the site.

Deer Island Concept IV - "The Ring Concept"

This concept would use the excavated soil from the drumlins and the basin excavations to the maximum extent possible, as shown in Figure 9.2.2-4. Approximately 4 million cubic yards of earth could be placed in a ring that would completely surround the treatment facilities with a manmade series of drumlins. These drumlins could be forested and landscaped. By these and other specific design means, visual impact of the new plant upon the harbor and the adjacent communities could be minimized.

Landforms

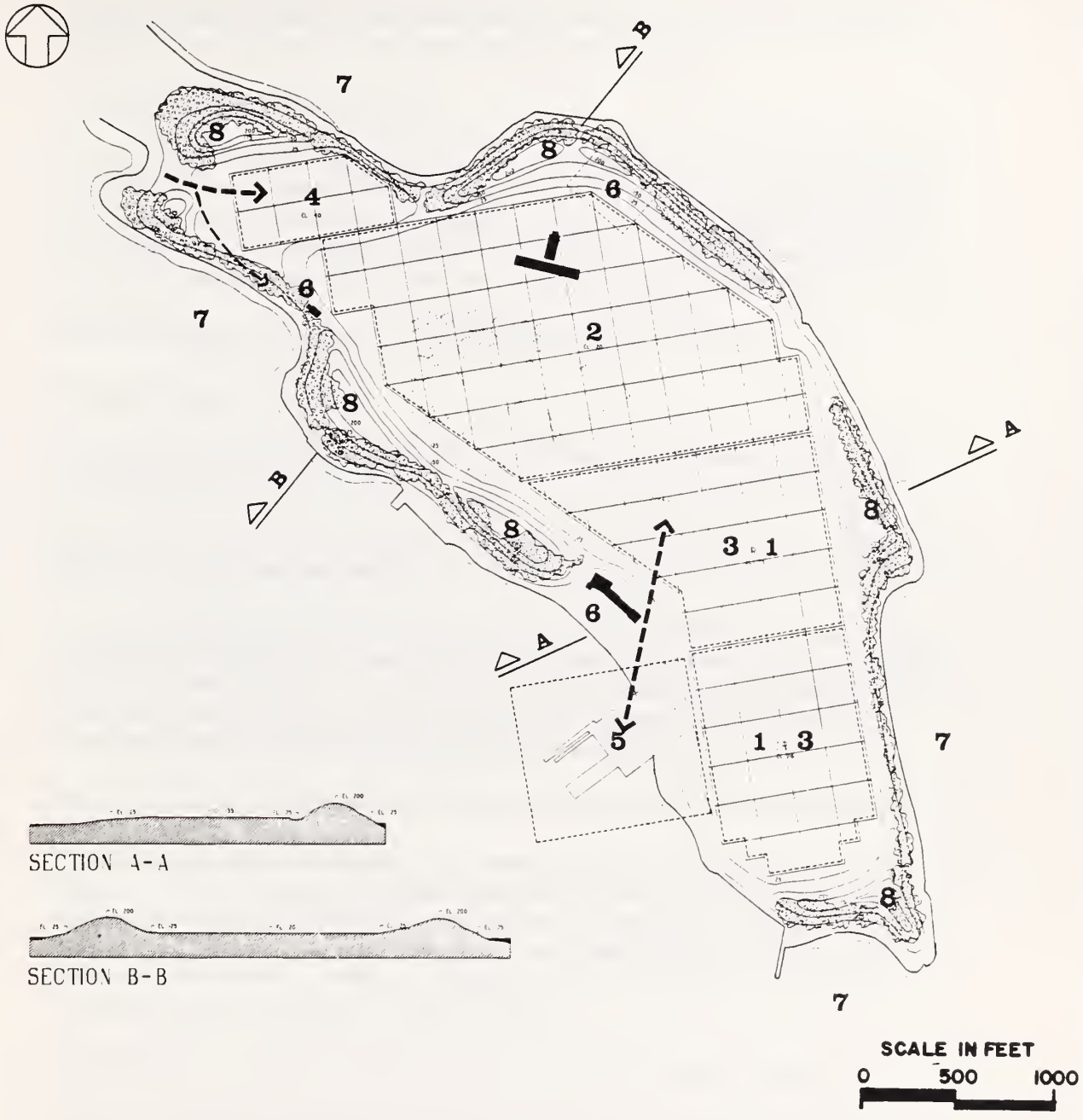
The excavated soil from the existing drumlins would be placed at an approximate minimum base elevation of 140 ft around the entire plant. From the base berm level, apparently random higher peaks would rise to levels of 210 ft and 220 ft. These higher levels match the height of the existing central drumlin, and coincide with the general height of the other drumlins in Boston Harbor.

The general grade level of the plant would be approximately elevation 125 ft. Preliminary geological review indicates that the excavated soils should provide suitable fill for the landforms proposed. For the Harbor Perspectives portion of the report it has been assumed that a 1:2 gradient for the berm slopes can be constructed.

The placement of the higher peaks would be rigorously calculated to fit into available sites on the island, and would serve the specific purpose of screening particular views into the plant from adjacent landmark view points. Therefore, a series of high ridges would be placed at the northern edge of the island, screening the view from Winthrop. Another series of peaks would surround the southern edge, and the sludge tanks contained therein, to screen views from Long Island. Similarly, since the central area of the site would remain fairly high at elevation 135 ft (related to the primary treatment facilities), a series of peaks would be created on the southwest shoreline to screen the view of the plant from Logan Airport and President Roads.

Buffer and Public Recreation Zones

The manmade drumlins serve as a three-dimensional buffer zone in this concept. It is proposed that the outer slopes, toward the water and the communities, be heavily planted with shrubs and trees. This outer zone (Areas 7 and 8) would continue uninterrupted to the water's edge, and would be primarily dedicated to passive, public recreational uses. In this zone a perimeter path could be located, which the public might be allowed to use, affording dramatic views into the plant area and around to the harbor. Bike trails, footpaths, and scenic lookouts could be planned in these zones for the public. A new use for the old pumping station could be




**Legend**

- Vehicular Access
- Existing Treatment Plant Structures
- Historic Buildings
- Mean High Water Level 110.6
- New Berms
- Usable Area: 107 Acres
- Trees & Shrubs
- 1 Primary Treatment Zone
- 2 Secondary Treatment Zone
- 3 Sludge/Storage Zone
- 4 Admin./Maintenance Operations Zone
- 5 Water Access Zone
- 6 Potential Historic Preservation Zone
- 7 Public Recreation Zone
- 8 Buffer Zone

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**FIGURE 9.2.2-4**
**DEER ISLAND HARBOR PERSPECTIVE**
**ALTERNATE CONCEPT IV**

designated within this zone, should detailed planning indicate the compatibility of this use with other island activities, and with other MWRA planning decisions.

The pier facilities are shown as Zone 5.

Treatment facilities Zones 1 to 4 would measure approximately 107 acres. This concept would place Zone 4 administration at the northerly entry of the site from Point Shirley. From this location, the administration zone would control vehicular access from Point Shirley to the plant, while being close to Boston Harbor to offer dramatic views of the Boston skyline. It would be furthest removed from the pier zone and the old pumping station.

Historic buildings and the location of the cemetery are shown as Zone 6.

Preliminary Impact Observations

The impact of this concept with regard to the social, technical, and environmental considerations is as follows:

Social. The "ring concept" is based upon minimizing the visual impact of the plant upon Boston Harbor and the adjacent communities.

As part of the first phase of construction, an adequate amount of earth could be moved to the northerly side of the island to screen Winthrop from the view and noise of the plant, provided that the land were available. If this manmade drumlin is subsequently well-landscaped, and the Point Shirley side dedicated as a recreational park, the impact of the ensuing years of construction activity on the remaining island could be mitigated.

Plant noise and odor could be reduced by virtue of the proposed landforms and landscaping.

The concept proposed for the island in this alternative would have a hidden portion (the plant), and a visible manifest buffer zone. The manifest buffer zone could be developed and dedicated to passive public recreation, particularly by the neighboring community. The recreational environment of the perimeter of the island could be left as a "wilderness isle." The proposed landforms on the Boston Harbor side of the island would create climatically comfortable micro-environments for public recreation.

Land adjacent to Deer Island would remain residential and semi-rural in character.

The scenic quality of the island would be enhanced, while the historical image of post-glacial drumlins, creating an appropriate context for historical buildings, could be preserved.

Technical. The area available for the footprint of the treatment facilities Zones 1-4 would be the least amount allowed by any of the design concepts.

Modification of treatment facilities for operational changes or greater flexibility, if ever required, would require removal of portions of the perimeter landforms. A future planning

possibility would be to leave a larger area within the perimeter landforms to accommodate unexpected needs.

This concept would build the inner areas of the treatment facilities to a general level of 125 ft, which is well above mean high flood level. An additional protection to the facilities from storm surges and gale winds would be provided by the perimeter landforms which would maintain a minimum elevation of 140 ft and could act as a protective dike.

A minimum of excavated earth, approximately 200,000 cubic yards, would have to be removed from the site. This concept therefore, would necessitate the minimum on-loading pier facilities and minimum barging.

Safety and security concerns related to harbor traffic are most favorable in this concept.

Environmental. The proposed buffer and recreational zones of this concept would be most apt to support the growth and survival of trees and shrubs, due to the protective environments provided by the proposed landforms. Micro-climates toward the Boston Harbor side of the island would be better shielded from the wind, and comfort conditions for human usage would be more easily attained in these zones.

The administration and operations buildings of the plant would be placed in protected micro-environments conducive to placemaking and site planning designs that would integrate the outdoors and the indoors. The MWRA staff would work in a more climatically comfortable environment created by designing with natural forces.

The palette of wildlife on the island would be more diverse, and larger than that in Concepts I and II, and the conditions for wildlife survival would be the best of the four concepts.

The proposed landform could completely enclose the plant. The encircling landform may restrict air circulation patterns over and within the site.

Deer Island Harbor Perspective Conclusions

Of the alternative planning concepts considered, those emphasizing the technological image of the facility, Alternatives I and II, are less socially and environmentally acceptable. These alternatives require a larger amount of off-island movement of excess excavations, and do not recreate the historical harbor island image.

The alternative planning concepts III and IV are the most socially and environmentally acceptable. These alternatives constrain the amount of space available for the treatment process, and minimize the need for off-island movement of materials.

Section 9.3, Deer Island, evaluates conditions affecting implementation of the planning concepts of either Alternative III or Alternative IV.

## 9.2.3 HARBOR PERSPECTIVE LAND USE EVALUATION - NUT ISLAND CONCEPTS

For Nut Island, as for Deer Island, alternative land use concepts were identified and evaluated in the Harbor Perspective Report. At Nut Island, the development of concepts focused on the type of reuse: active or passive. From this screening process, two concepts were selected for their relative merits, to be studied in greater detail. The program of engineering needs on Nut Island requires the removal of the existing treatment plant, which occupies most of the island, and replaces the plant with a much smaller headworks structure located somewhere on the island. Operation of the existing treatment plant must be maintained until start-up of the new headworks facility. The site must also accommodate the MWRA pier facility that is under design and provide service access to the headworks and the pier. The remainder of the site could potentially be dedicated to open/passive recreation.

### Alternative Headworks Locations

The first series of studies focused upon the size and potential locations for the headworks. It was determined through preliminary engineering studies that the headworks would likely consist of an approximately 140 ft by 180 ft below-grade footprint with an above-grade structure of about 14,000 $ft^2$, at a height of 35 ft. (The existing administration building is approximately 35 feet high). The preliminary land use evaluation of Nut Island identified three locations for new headworks facilities. These site options are shown in Figure 9.2.3-1 as sites A, B, and C. During discussions of the Harbor Perspective Report with abutting neighborhood residents and with the MWRA staff, two additional sites, D and E, were identified.

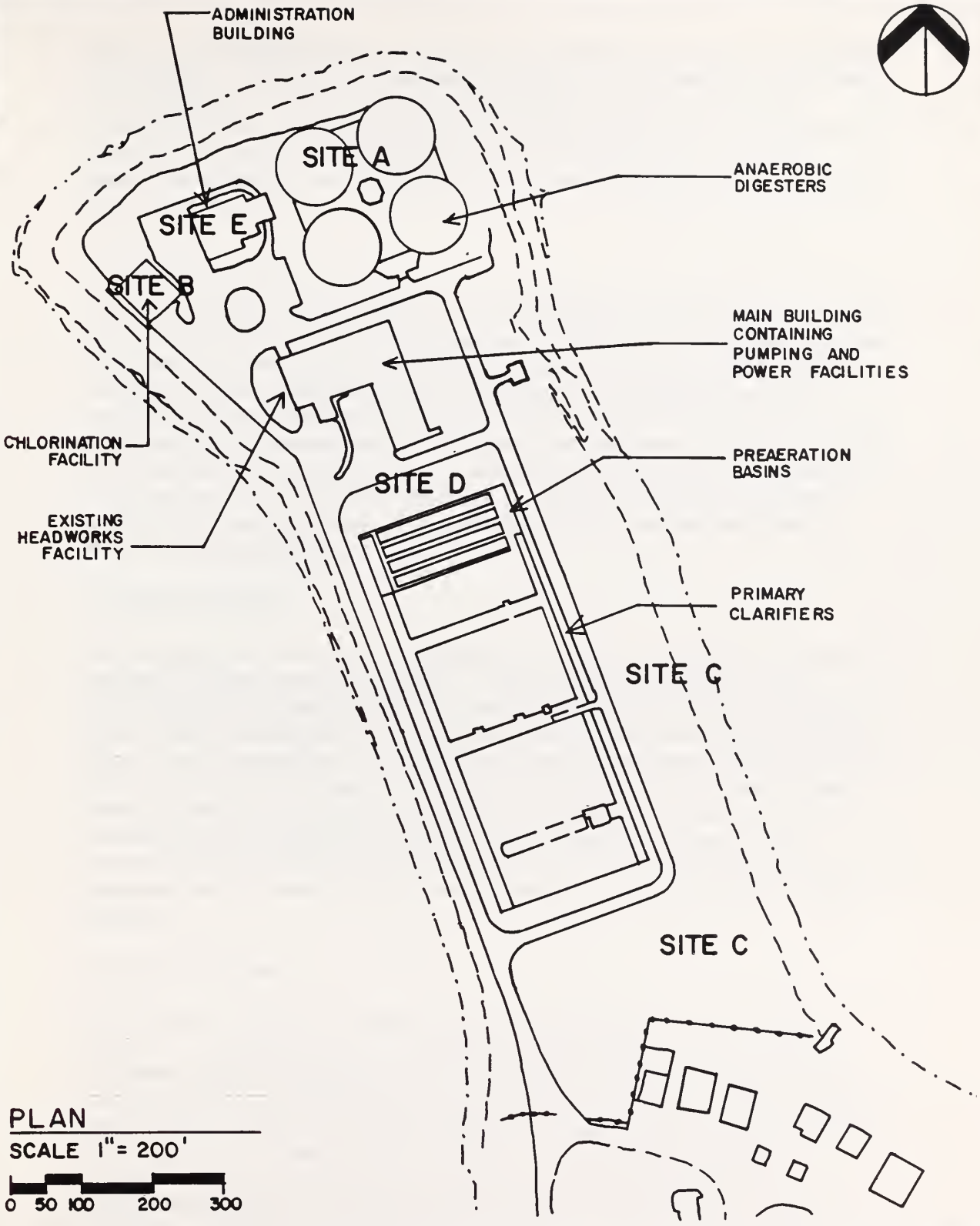
The site options were identified and evaluated based on engineering feasibility and on the provision of a land area buffer between the headworks facilities and the Hough's Neck residents, allowing viewing of the harbor from the prime vantage point at the northwest corner of the island.

#### Nut Island Site Option A

This option would locate the headworks in the area of the existing anaerobic digesters. Social advantages of this option are that the facilities are removed from the Hough's Neck residents and that the layout allows harbor views from the northwest corner of the island. Technically, this option has the advantages of not disrupting existing treatment plant operations and allowing for an optimum headworks facility layout. A disadvantage of this site is that all of the digesters would have to be taken out of service before decommissioning of the treatment plant. Construction of the headworks could not begin until interim residuals transport and treatment facilities with capacity to accept raw primary sludge were available. If these raw sludge facilities were not available for the scheduled start of construction of the new headworks facility, then the construction schedule would have to be delayed 2-1/2 to 3 years until new residual facilities were available at Deer Island.

#### Nut Island Site Option B

This option locates the headworks on the site currently occupied by the chlorination building. This is the only feasible site for new headworks facilities at the northwest corner of the




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 9.2.3-1**
**NUT ISLAND**
**SITE ALTERNATIVES**

island. A social advantage of this option is that it is at a maximum distance from the Hough's Neck residents. Technically, implementation of this option is not dependent upon the interim residuals program. This option has several disadvantages, both social and technical. Socially, this location prevents viewing of the harbor from the northwest corner of Nut Island. Technically, this option requires relocation of the chlorination facilities for an interim period of approximately 2 years. Also, Site B is very narrow, making for a costly, less than optimum site layout.

Nut Island Site Option C

The new headworks could be located in the corridor defined by the primary clarifiers and the eastern shore of Nut Island. The corridor extends from the location of the preaeration basins to the southern property line of the treatment plant. The social advantages of this option are that it allows viewing of the harbor from the northwest corner of the island, and that it provides a large open space area at the northern end of the peninsula. A technical advantage of this option is that implementation is not dependent upon the interim residuals program. A social disadvantage of this option is that it is closer to the Hough's Neck residents compared to other options. Technically, the disadvantages of this plan are the extensive foundation required due to poor soil materials, and the less than optimum headworks facility layout allowed by the existing facilities.

Nut Island Site Option D

This alternative would locate the headworks facility in the open space between the north end of the primary clarifiers and the Main Building. Social advantages of this option are that viewing of the harbor would be allowed from the northwest corner of the island, and that the facility would be removed from the Hough's Neck residents. The technical advantages of this option are that implementation is not dependent upon the interim residuals program, and that an optimum headworks facility layout can be designed. Disadvantages of this option are both social and technical. The technical disadvantages of this option are the required rerouting of wastewater treatment plant flow to and from the primary clarifiers, the required early decommissioning of the preaeration basins and the portion of the Main Building that houses the preaeration basin air blowers, and the extensive foundation necessary to overcome poor soil conditions.

Nut Island Site Option E

This alternative would locate the headworks facility in the vicinity of the Administration Building. A sub option at this site would split the headworks facility into two structures, one located on the east side and one on the west side of the Administration Building. This option has the social advantage of being located in an area that is removed from the Hough's Neck residents. However, this option would prevent viewing of the harbor from the northeast corner of the island. Technically, this site option has several disadvantages. The construction of the headworks facilities on the site of the administration building would require difficult and costly rerouting of the treatment plant outfall conduit and would not allow for an optimum headworks facility layout. The split headworks facility sub option would require replacement of the chlorination facilities and taking all of the digesters out of

service before decommissioning the treatment plant. Removing the digesters could not be acomplished until interim residuals facilities were available or until new residual facilities were available on Deer Island. Waiting for residual facilities on Deer Island would delay construction for 2 1/2 to 3 years. Also, the headworks facility layout for two structures is poor from an engineering standpoint.

Alternative Land Use Concepts

The two alternative land use concepts presented below are architectural recommendations developed in the Harbor Perspective studies, and are intended to provide the MWRA with tools to facilitate subsequent planning and decision making for Nut Island redevelopment.

For discussion purposes, the two alternative concepts have been developed with the headworks structure, located at the far end of the island. Each concept is a variation on the same basic theme, since the essential variables and site size on Nut Island are more limited than those available on Deer Island. The concepts differ in level of active recreation and extent of public access. The common design elements shared by the two concepts are:

- The headworks structure would be surrounded by a security fence and control gate.
- The general ground elevation of the above-grade headworks structure is at elevation 125 ft. (The present ground elevation at the administration building is approximately at elevation 130 ft.)
- The structure could be screened from Hough's Neck by a peripheral landform whose average level would be approximately 140 ft., with a peak elevation of 180 ft.
- The landform would be landscaped with shrubs and trees.
- The location of the roll-on, roll-off pier facility is on the northern tip of Nut Island. The pier's elevation is 116 ft, as proposed in the draft report on the on-island pier facility.
- A vertical landmark and lookout would be placed at the water's edge atop the proposed landform. This lookout would be open to the general public.
- Limited public parking would be located to the south of the landform, and screened from view by trees and shrubs.
- A site access road would be located on the western edge of the peninsula to encircle the landform, providing access to the proposed parking area, headworks facilities, and pier.
- There are no known historic buildings nor any archaeological sites on Nut Island.

Nut Island Land Use Concept I

This concept maintains the basic common design elements enumerated previously, and proposes a low activity, passive recreational program for the site. The area between the proposed landform and Quincy Great Hill in Hough's Neck might be landscaped with trees. Public footpaths and picnic tables would also be provided.

The impact of this concept with regard to the social, technical, and environmental considerations is detailed below.

Social. Public recreation and open space would be the main contribution of this concept. The proposed landforms, lookout, footpaths, picnic table areas, limited parking areas, and regionally adapted landscaping designs would create climatically comfortable micro-environments conducive to passive, public usage. The scenic quality of the island would be greatly enhanced, while the historical image of post-glacial drumlins would be recreated.

Technical. The general level of the grade around the headworks would be set at elevation 125 ft., which is above mean high flood level. The proposed perimeter landform provides the facilities with an additional protection from storm surges and gale winds. The earth fill for the proposed landforms and filling of the existing facilities would need to be brought from off-site locations.

Environmental. The proposed buffer and recreational zones in this alternative would support the growth and survival of trees and shrubs on the southern side of the proposed landforms. The present site is flat, wind-swept, and not very conducive to plant growth. This condition would be transformed by the proposed protective landform and landscaping. The environment around the headworks facility, which would have an administrative staff zone, would be protected from natural forces and would be climatically comfortable. The palette of wildlife on the island would increase and diversify.

Nut Island Concept II

Concept II differs from Concept I mainly in the higher level of active recreation proposed for the site, yet maintains the common design elements discussed earlier. A public boat club and boat dock location on the northwest shoreline is a possible institutional usage that might heighten the water and boating character of the gateway/peninsula context of Nut Island. A corollary increase in parking related to the boat club might occur.

Some landscape/land use variations for the area between the proposed landform and Quincy Great Hill in Hough's Neck have also been considered. The area in question, where the former sedimentation tanks have been located, could be left as a grassy meadow or lightly planted with trees to highlight the more heavily landscaped "man-made drumlin" at the peninsula's tip. Picnic tables might be limited to only a few on the proposed new landform.

The impacts of this concept with regard to the social, technical, and environmental considerations would be very similar to those for Concept I and are as follows:

Social. More active recreation and greater public access to the site would be the main difference between this concept and Concept I. A boat club and harbor lookout are envisioned, as well as an MWRA pier that could be open to the public. These elements would contribute to the creation of a regional park where the general public would have a spectacular gateway view and could have access to Quincy Bay and Hingham Bay. Climatically adapted landscaping designs would create comfortable micro-climates for public recreational activities. A change in traffic volume might be experienced in the abutting communities, due to the greater public access proposed for Nut Island. The scenic quality of the island would be enhanced, while the historical image of a post-glacial drumlin would be recreated.

Technical. The general level of the grade around the headworks would be set at elevation 125 ft, which is above mean high flood level. The proposed perimeter landform would provide an additional protection to the facilities from storm surges and gale winds. The earth fill needed for the landforms and filling of the existing facilities would have to be brought from off-site locations. A minor increase in boat traffic would be experienced if the proposed boat club were established.

Environmental. The proposed buffer and recreational zones in this alternative would be able to support the growth and survival of trees and shrubs on the southerly side of the proposed landforms. The present site is flat, wind-swept, and not very conducive to plant growth. This condition would be transformed by the proposed protective landform and landscaping. The proposed grassy meadow might tend to be windy. The environment around the headworks facility, which will have an administrative staff zone, would be protected from natural forces and would be climatically comfortable. The palette of wildlife on the island would increase and diversify.

### Nut Island Harbor Perspective Conclusions

The site options that are conceptually the most socially and technically acceptable are sites A and D. These sites are removed from the Hough's Neck residents, allow views of the harbor from the prime vantage point at the northwest corner of the island, and allow for an optimum layout of the headworks facility.

The alternative land use concepts developed for Nut Island focus on either active or passive re-use of the land not used for the new headworks facilities. Concept I, which proposes a low activity, passive use for the open space on Nut Island, is the recommended concept for development of Nut Island. This concept would encourage recreational use on a local basis. Also, development of the site would visually minimize both the headworks facility structure and proposed landforms screening the facility.

## 9.3 DEER ISLAND SITE PLANNING

This section evaluates the adaptability of the treatment alternatives to the Deer Island site. The methodology of this evaluation process integrates the special requirements of alternative unit processes with the existing conditions, site constraints, site planning objectives, mitigation goals, and operational considerations, and then assembles and assesses the various

alternative layouts. The requirements associated with support facilities are defined. The alternative layouts are presented with an examination of the area requirements of the unit processes. The impact of vertical plant alignment is also presented in this section.

### 9.3.1 SITE CONSTRAINTS AND EXISTING CONDITIONS

The alternative layouts of the unit processes considered for Deer Island are constrained by existing conditions, proposed concepts from other elements of planning, and other MWRA projects.

The constraints imposed by existing conditions are shown on Figure 9.3.1-1. These include the following:

- The existing primary plant must be maintained, including the outfall, until replacement facilities are completed.

- The existing North Main pump station and Winthrop terminal will remain in service as part of the new plant.

- Applicable state law requires early decommissioning (1989) of the prison. The responsible agency has suggested that the prison may not be decommissioned until 1991-1992. Thus, for planning purposes the secured area of the prison site is assumed to be either unavailable and/or subjected to restricted access during the initial years of construction activity.

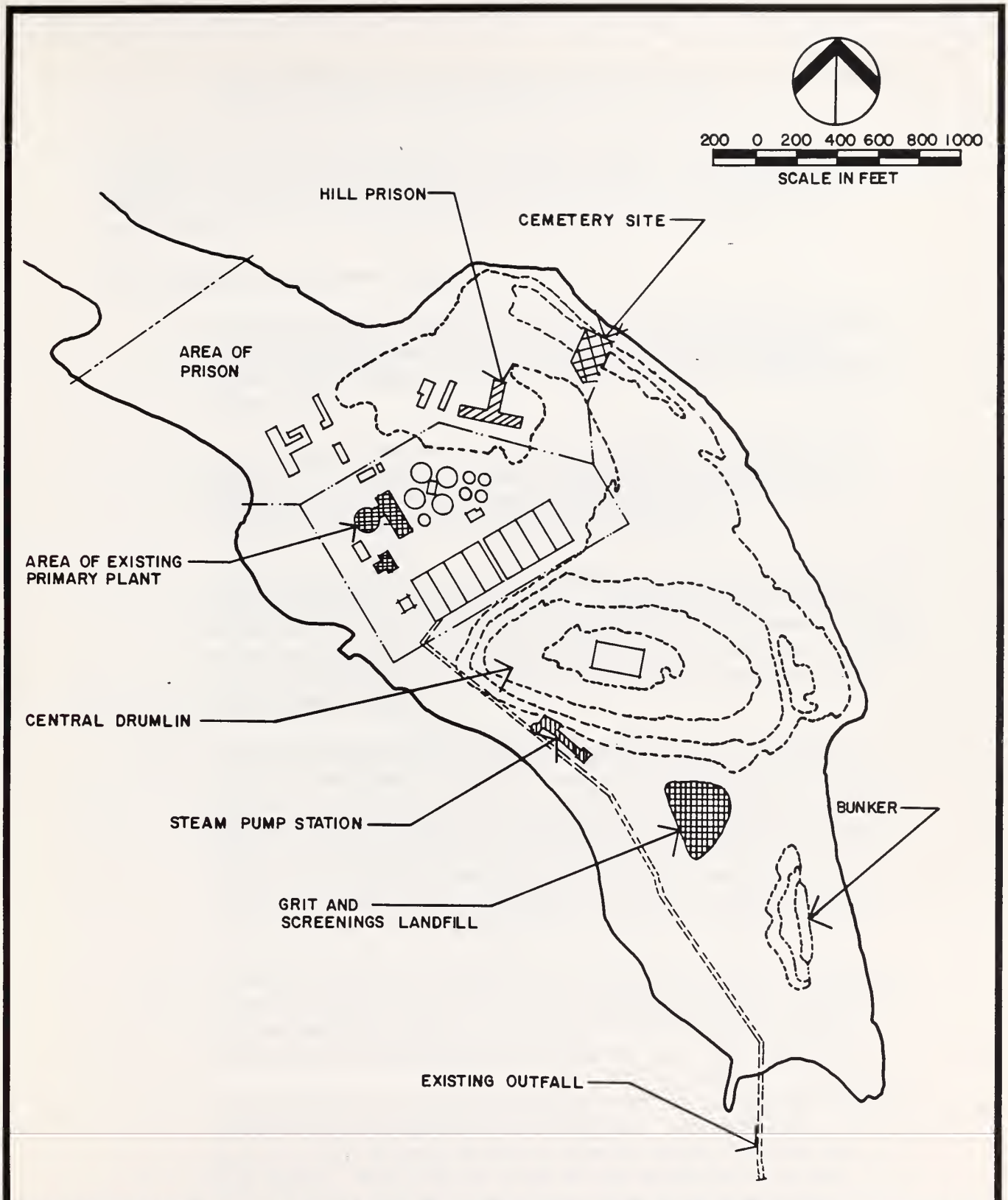
- The central drumlin establishes the present topography of the site. Placement of unit processes in relation to the central drumlin, in both elevation and in plan, will determine the volume of site excavation required.

- At the southern end of the site, within the former Fort Dawes, are abandoned gun bunkers. These structures will be demolished.

- There are four structures on the site that have been identified as being eligible for designation on the National Register of Historic Structures: the old steam pumping station, the hill prison, the prison superintendent's house, and the Queen Anne farm house.

- There is a cemetery site located in the northeast portion of the site. Construction of unit processes in this area is not expected to be allowed. The creation of landforms and/or walkways within the cemetery area is subject to a final determination by the state's historic preservation officer.

- There are several acres at the southern foot of the drumlin that have been utilized for dumping of grit and screenings from the existing plant operations. These occupy an area that is intended for use as part of the new treatment facilities. Accordingly, the removal, and relocation either on-site or disposal off-site, have




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 9.3.1-1<br>DEER ISLAND<br>SITE CONSTRAINTS-EXISTING CONDITIONS |
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been evaluated with the recommendation to permit and construct a permanent grit and screenings landfill on-site in the southwestern tip of the island.

In addition to the existing conditions, there are a number of projects either in progress or expected to proceed in the immediate future, which impose additional conditions on the site's development. It must be noted that these projects are in varying states of transition and are subject to change.

These on-going projects include the following:

- The interim residuals management program that will handle sludge from the existing primary facility for off-island disposal. An area in the vicinity of the existing plant and on the southern end of the island may be required for this project, between 1990 to 1995.

- A scum fixation demonstration project. This is a program to chemically fixate the plant's scum. This project is estimated to require land for the chemical fixation facilities and will produce several cubic yards a day of fixated scum. This is to be stockpiled on-site until it can be removed off-site via the piers.

- A compost demonstration project, which is currently located between the western end of the primary basins and the western shoreline. This project occupies approximately 1 acre of land, with amendments storage (woodchips) in front of the northern wing of the old steam pumping station occupying an additional 0.2 acres. This project is expected to be operational through the construction period of the new primary plant. The status thereafter is unknown.

- Fast track improvement projects that all require staging areas for the contractors involved. Current plans of the MWRA's construction division is to designate an area west of the administration building for the staging needs. In addition, the excavated material from the construction of the engine generator buildings has been stockpiled eastward of the existing primary basins and may not be removed from the site. The rehabilitation of the primary basins includes the dredging of approximately 75-100 cubic yards of grit from the influent channel. This is to be temporarily stockpiled on-site; the location and final disposal of this stockpile is unknown at this time.

- In addition to the fast track improvements, the Authority has made a commitment to convert the disinfection system from liquid (gaseous) chlorine to sodium hypochlorite once pier facilities are available. The location of interim disinfection facilities and the associated sodium hypochlorite storage tanks has not yet been established.

- The sewerage division is currently entering the design stage for additional personnel facilities to support the operation of the existing plant. These facilities are expected to consist of parking facilities for employees vehicles, lunchroom, and locker facilities. While a size and location for such facilities has not yet been selected, it appears likely that it will be located in the vicinity of the existing administration facilities and North Main Pumping Station.

- The Authority has retained a consultant to evaluate the system-wide (water and wastewater) laboratory and maintenance needs. The scope of that study will naturally include within it the proposed plant's maintenance, warehousing, and laboratory needs. The conclusion of that study may be that for efficiency of operation, the proposed on-island maintenance and laboratory facilities should either be expanded or contracted.

### 9.3.2 DEER ISLAND SITE PLANNING OBJECTIVES

The development of Deer Island Site Planning objectives must also accommodate the goals and proposed concepts from the other elements of planning. These are shown in Figure 9.3.2-1. The goals include those from the Harbor Perspective section of this report, RMFP, and the Pier Facility Plan.

- The site development goals from Harbor Perspective are to provide a visual buffering berm whenever possible and maximum open space adjacent to the facilities -- particularly at the north end of the island. It was also established that noxious elements should be kept away from the northern end of the island.

- The area to be utilized for piers and construction staging as proposed by the "Draft On-Island Water Transportation Facilities" report is located on the southwestern shore and has been shown as a site constraint.

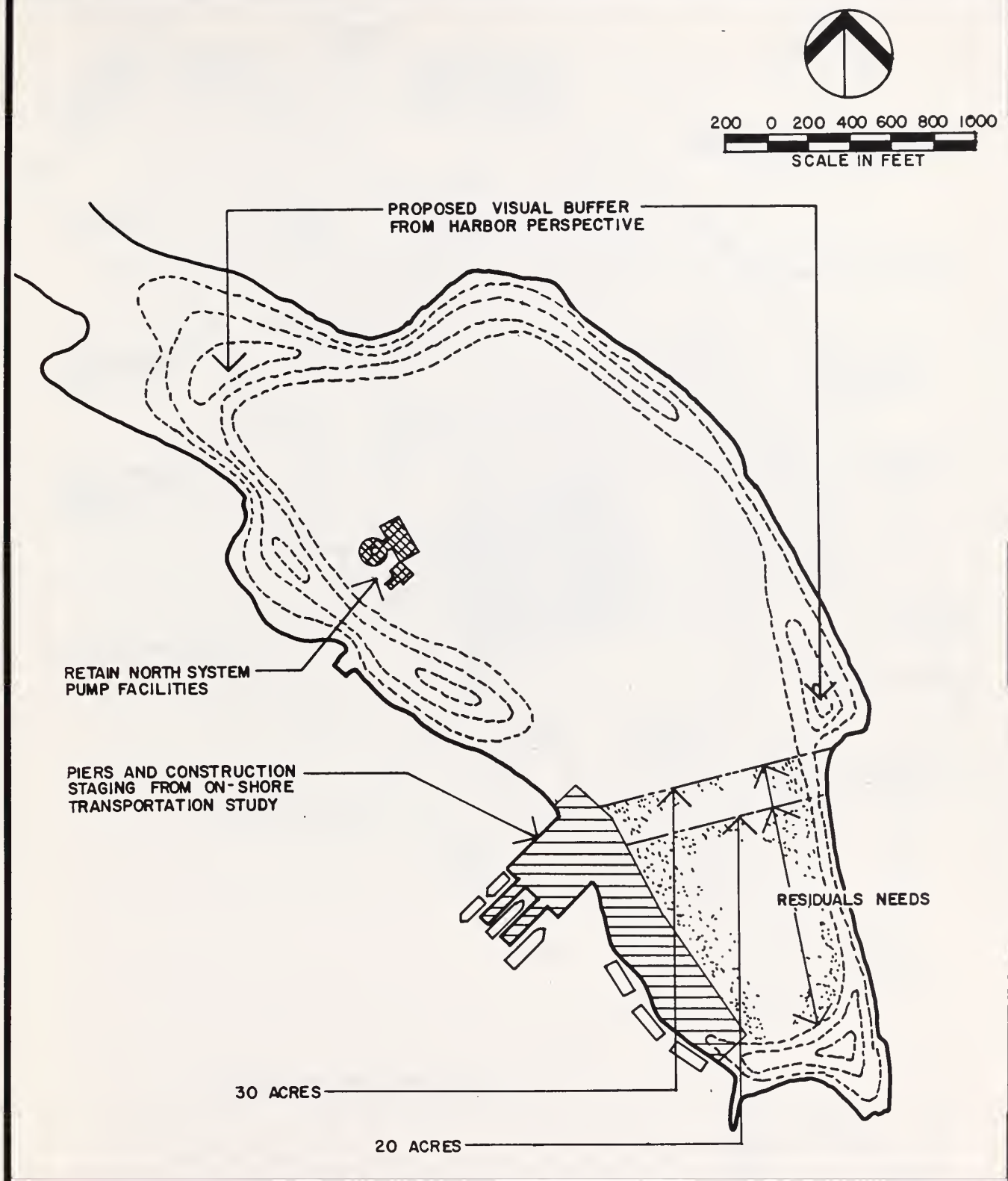
- The range of possible area requirements associated with the handling of residuals is depicted on the figure as a site constraint. Options under consideration for residual handling vary from less than 20 acres to greater than 30 acres. In the options for plant layout examined in this section, approximately 20 acres have been used.

- Minimizing the need for off-island disposal of surplus excavation is included in the planning objectives. This can be achieved by either reducing the volume of material to be excavated or by increasing the available locations for on-island reuse.

- One of the major goals is to construct an operable and reliable facility. Accordingly, the site layouts must provide for optimum efficiency in flow distribution and process control. The proposed organizational framework for operation of the plant requires that operations facilities be sited within the zones (primary, aeration, secondary) of the plant. The layouts must also allow for sufficient power capabilities and non-process facilities, such as maintenance facilities and administrative support functions.

### 9.3.3 ALTERNATIVE DEER ISLAND SITE LAYOUTS

The site layout concept presented in the FEIR, reproduced as Fig. 9.3.3-1, was based on an average flow rate of 500 mgd. Analysis of flow and load data has shown that while 500 mgd was a reasonable estimate of annual average flow, the average flow during sustained high groundwater conditions will be substantially greater. As summarized in Section 6.2, the projected average


200 0 200 400 600 800 1000
SCALE IN FEET
PROPOSED VISUAL BUFFER FROM HARBOR PERSPECTIVE
RETAIN NORTH SYSTEM PUMP FACILITIES
PIERS AND CONSTRUCTION STAGING FROM ON-SHORE TRANSPORTATION STUDY
RESIDUALS NEEDS
30 ACRES
20 ACRES

| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 9.3.2-1<br>DEER ISLAND<br>SITE CONSTRAINTS-PROPOSED CONCEPTS |
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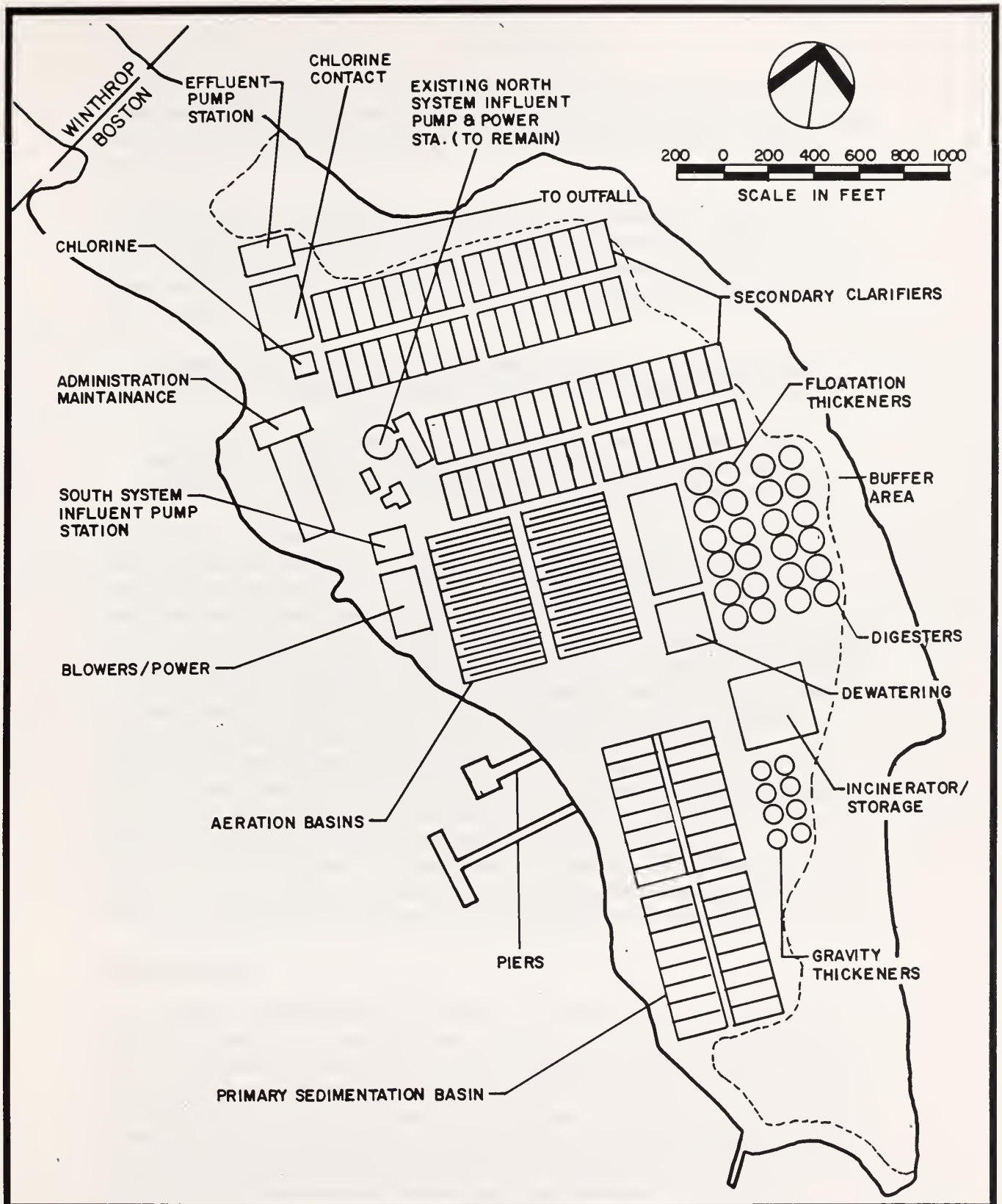


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**FIGURE 9.3.3-1**
**FACILITY SITING - FINAL EIR**

annual flow is approximately 480 mgd, but the sustained seasonal average flow during high groundwater conditions is 670 mgd. It is this rate of flow, 35 percent greater than the average used in the siting FEIR, that essentially controls the area requirements of the treatment alternatives.

A systematic analysis was conducted of the treatment process alternatives to determine if, in fact, they all could be accommodated on Deer Island without violation of the goals established by the mitigation commitments of the FEIR and the Harbor Perspective. For this analysis, unit process alternatives for primary treatment and secondary treatment were assembled into five process trains as follows:

Alternative I: Unstacked primary and secondary clarifiers with air activated sludge
Alternative II: Stacked primary and unstacked secondary clarifiers with air activated sludge
Alternative III: Stacked primary and secondary clarifiers with air activated sludge
Alternative IV: Stacked primary and secondary clarifiers with a coupled system
Alternative V: Stacked primary and secondary clarifiers with oxygen activated sludge

For each of the five alternatives, the process areas are organized as four batteries (with each battery containing an equal number of basins). The treatment process train is identical for each of the five alternatives and is as follows: Wastewater from the North System is received at either the North Main Pumping Station or Winthrop Terminal. Wastewater from the South System is received at the South System Pumping Station. The North System flow receives grit removal and is then combined with the South System flow at the primary distribution box, from which the flow is distributed to four batteries for primary treatment. After treatment in the primary clarifiers, the flow enters the secondary distribution box where the flows are distributed to the four batteries of aeration basins. One of the primary batteries is configured so that during peak flow the primary effluent from that battery can be diverted through a screening structure and then to disinfection. Each battery of secondary treatment is associated with a battery of secondary clarifiers. The effluent from each battery of secondary clarifiers is collected and transferred to the disinfection process. After flows are disinfected, they are discharged. The organization of the treatment process provides for gravity flow through the plant. The need for effluent pumping (or intermediate pumping) of wastewater depends on the plant elevation and the length and diameter of the outfall.

Evaluation Process

The evaluation of the five alternatives is described in the following sections. Excluded from this part of the evaluation are the explicit requirements for the ancillary facilities such as power, administration and maintenance buildings, interprocess conveyance conduits, roadways, and areas that can be dedicated to buffer zones/open areas. Individually, these facilities are comparatively small. Cumulatively, however, they represent a significant area, and throughout the analysis a conscious effort was made to allow for these areas in evaluation of the options. These facilities and their definitions are summarized at the end of this section. The area occupied by these important support facilities is shown on the layouts.

The tank's footprint and geometry used for this analysis was based on 18-ft-deep aeration basins, 15-ft-deep clarifiers, and 24-ft-deep disinfection basins. The detailed evaluation of alternative variations in tank depth and geometry are examined further in Section 10.0.

It should also be noted that the primary and secondary clarifiers account for the majority of the land requirements associated with wastewater treatment, and define the possible plant layouts. Therefore, options involving variations of clarifier layouts are examined first.

Deer Island Alternative I: Unstacked clarifiers

This alternative consists of unstacked primary clarifiers and unstacked secondary clarifiers. The layout is shown in Figure 9.3.3-2. The process included in this layout is the most similar to the process layout shown in the FEIR. The main differences between this alternative layout and the FEIR layout are the location of primary units and residual treatment units, and the area required for the primary and secondary treatment clarifiers. This layout would occupy nearly the entire island, and would require that nearly all excavated and spoil material be transported off-site. The layout infringes on the buffering berms as proposed in the Harbor Perspective, limits the open space requested by commentors, and infringes on both the historical and archaeological sites on the island.

Deer Island Alternative II: Stacked Primary Clarifiers and Unstacked Secondary Clarifiers

This alternative consists of stacked primary clarifiers and unstacked secondary clarifiers. This layout, as presented in Figure 9.3.3-3, utilizes a south-to-north flow configuration. This flow configuration utilizes the existing topography, setting the primaries at a high elevation on the remnants of the central drumlin, possibly eliminating the need for effluent pumping. Locating the primaries to the south central portion of the site also minimizes any potential odor problems and optimizes the location of the pumping station from the South System (i.e. reduces the length of the interisland tunnel). However, the layout does not provide a smooth hydraulic transition between the aeration and secondary clarifier unit processes, which could present operational problems. This layout is somewhat asymmetrical. Channel lengths are quite long, and distribution of flows to and from unit processes may be difficult. The Alternative II layout uses almost the entire island with the exception of the area nearest Point Shirley. For this option, the buffering berm proposed in the Harbor Perspective Report could not be maintained as an unbroken ridge, but would be reduced to a series of small hills.

Alternative III: Stacked Primary and Secondary Clarifiers With Air Activated Sludge

The evaluation of the first two alternatives clearly shows the large area requirements associated with both primary and secondary clarification, and demonstrates the space saving advantage of stacked clarifiers. These units, if used, would reduce area requirements for clarification by about 40 percent. An evaluation was conducted using air activated sludge with stacked rectangular primary clarifiers and stacked secondary clarifiers. This alternative is depicted in Figure 9.3.3-4. During the evaluation of this alternate the elements were manipulated in a number of configurations. Configurations considered were: North to South Flow; West to East Flow; South to North Flow.

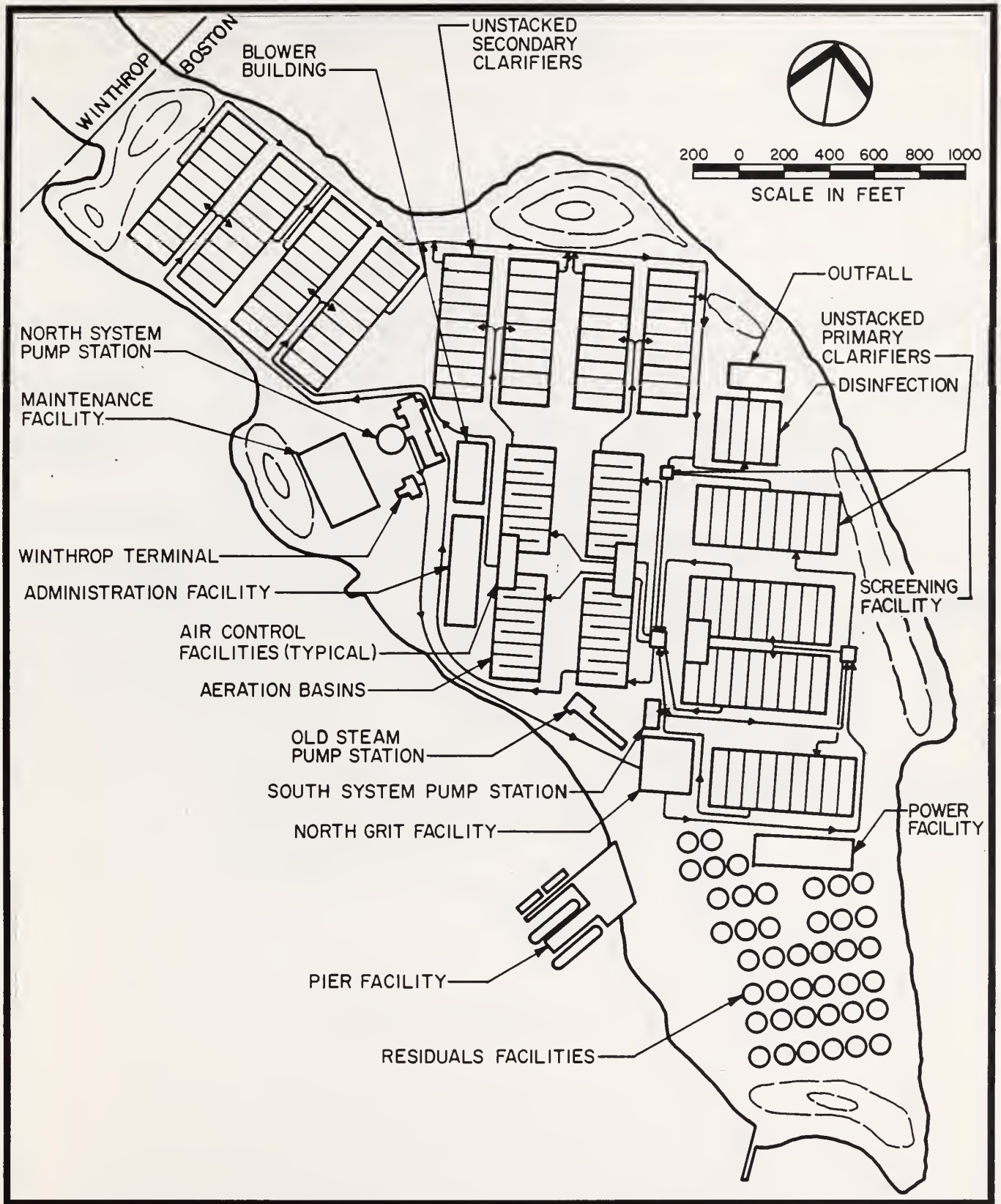


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**FIGURE 9.3.3-2**
**ALTERNATIVE I: UNSTACKED CLARIFIERS**

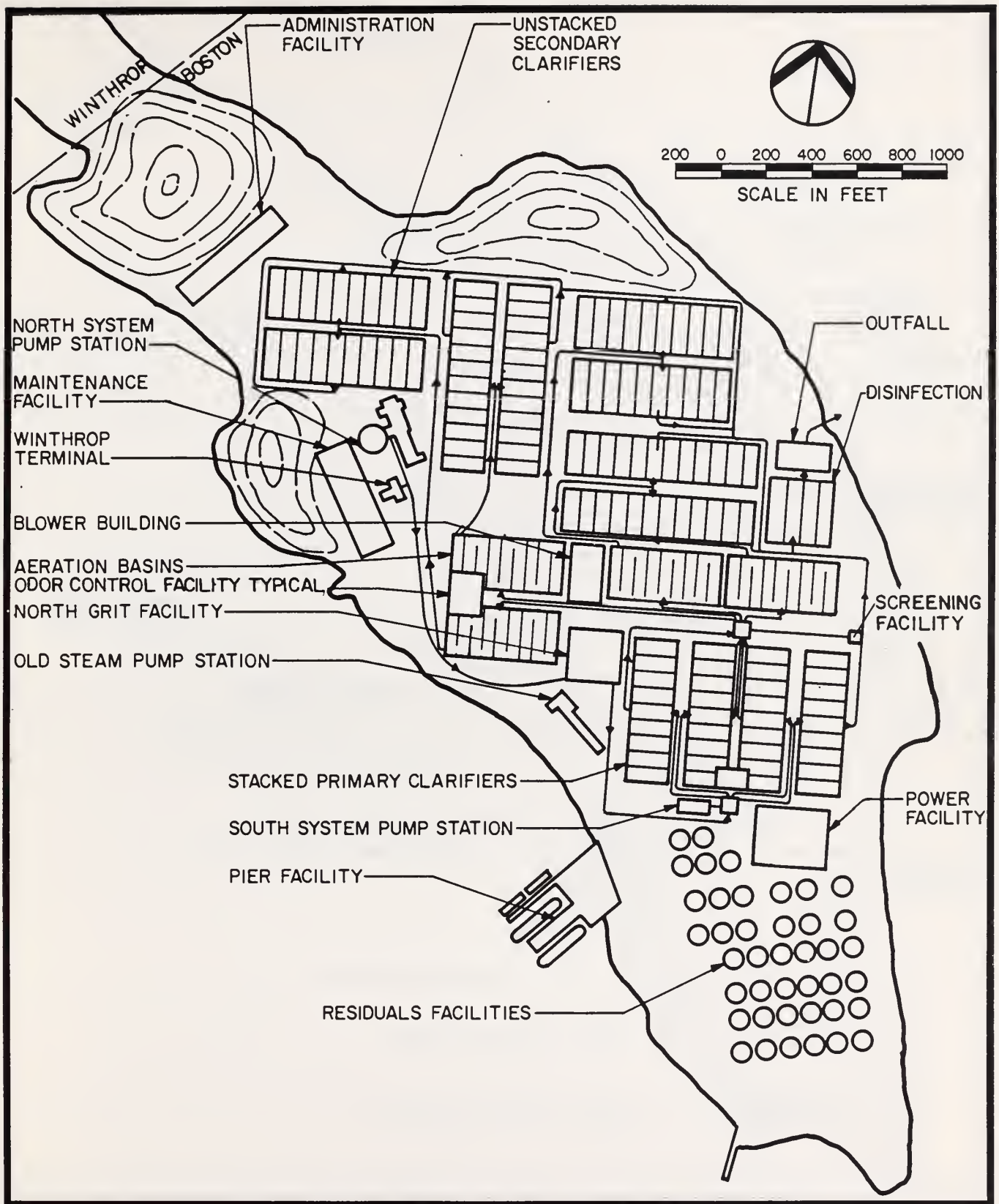


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**FIGURE 9.3.3-3**
**ALTERNATIVE II: STACKED PRIMARY AND UNSTACKED SECONDARY CLARIFIERS**

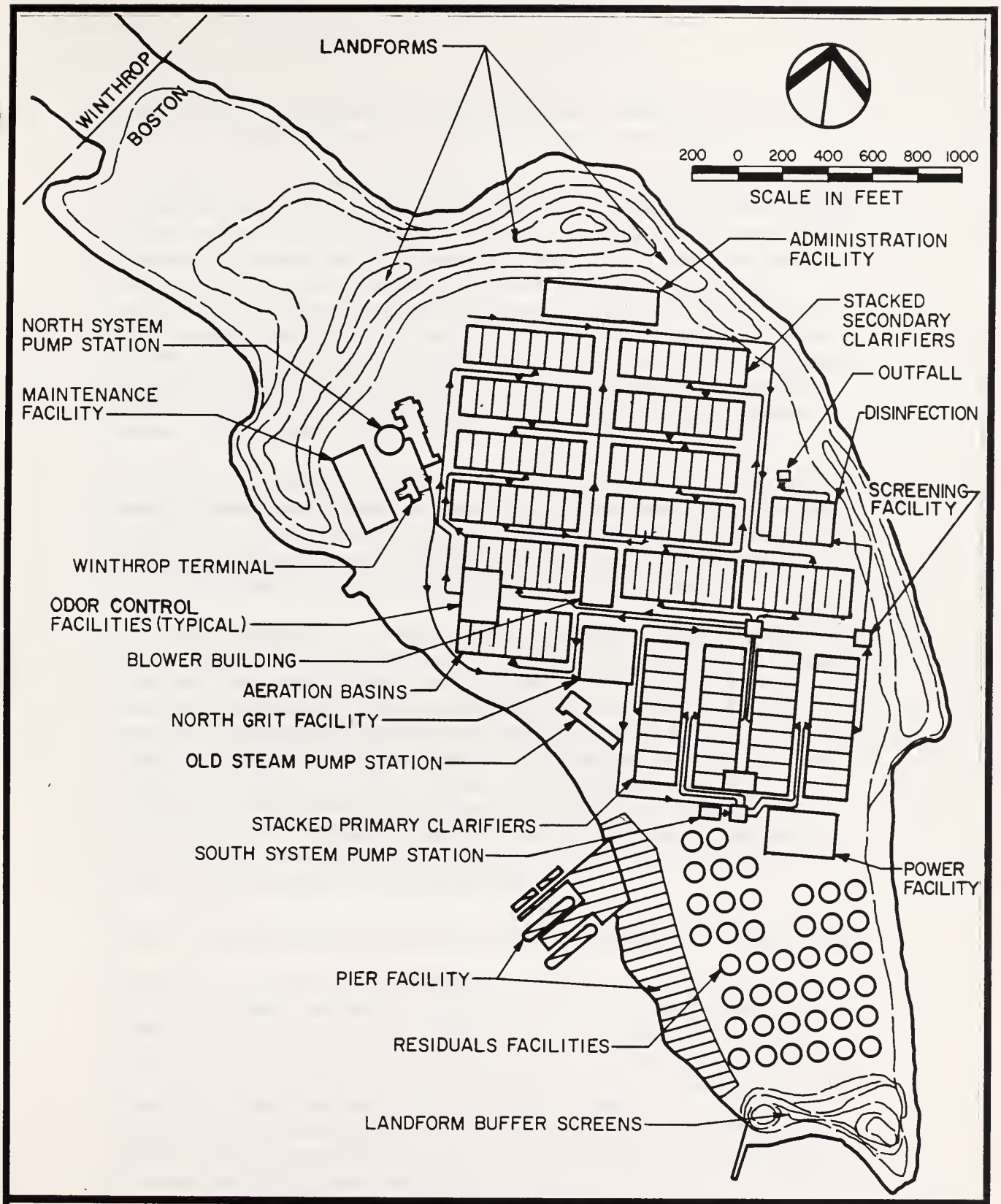


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**FIGURE 9.3.3-4**
**ALTERNATIVE III: STACKED CLARIFIERS WITH AIR ACTIVATED SLUDGE**

Of these alternative configurations, all resulted in minimum infringement on the proposed berms, and the potential to salvage the existing steam pumping station building.

The configuration of north-to-south flow (primaries nearer Winthrop, and secondaries nearer to the center drumlin) would provide all the benefits of the completely stacked scheme. However, it would not utilize the natural topography. In addition, this alignment would require more construction coordination, due to the location of the new tanks in relation to the existing plant's tanks. This alternative would locate the primary clarifiers at a relatively low elevation, which would require excessive earth moving to maintain gravity flow through the plant. Construction would involve building the two eastern batteries first, directing flow to these two, destroying the existing primary tanks and constructing the two new western batteries in their place. This is an approach that could significantly delay the overall construction schedule. This configuration would also site the primary clarifiers close to the adjacent population, which, as established in the Harbor Perspective section, is less desirable.

The west-to-east configuration would allow the South System pumping station to be located in a position minimizing conduit length, and would offer the benefits inherent with the stacked clarifiers. However, construction considerations preclude this configuration since, as above, two of the four batteries must be built and put into operation prior to the construction of the third and fourth battery in order to maintain operation of the existing facility.

Of these three configurations, the south-to-north flow configuration offered the optimal layout with both stacked primary and stacked secondary clarifiers. This configuration would maximize the benefits of the existing topography by locating the primary clarifiers on the central drumlin at a higher elevation, so that effluent pumping may not be required. Due to the location of the primaries, the South System pumping station could be located in an area which minimizes the length of the interisland conduit. This configuration would also provide for isolation of the primary processes at a far distance from the adjacent residential neighborhood. The alternative of stacked primary and secondary clarifiers results in a manageable footprint. This footprint's area is, in fact, slightly less than that considered in the siting FEIR. It would allow maximum compliance with the mitigation commitments and compliance with the goals of the Harbor Perspective.

Deer Island Alternative IV: Stacked Primary and Secondary Clarifiers With Coupled Systems

Alternative IV evaluated the use of stacked primary and secondary clarifiers, with a variation of the aeration segment consisting of a coupled system of trickling filters followed by air activated sludge. This layout is shown in Figure 9.3.3-5. The operation of the primary treatment plant is as described above. However, when the flow exits the primary clarifiers, it would enter a pump station instead of the distribution box. From this station, the flow would be pumped and equally distributed to the trickling filters. Following treatment in the trickling filters, the wastewater would be gravity fed to the aeration basins for subsequent treatment. As with the other alternatives, there is a one-to-one association between batteries of trickling filters, aeration basins, and secondary clarifiers. The operation of the aeration basins and secondary clarifiers is as previously described.

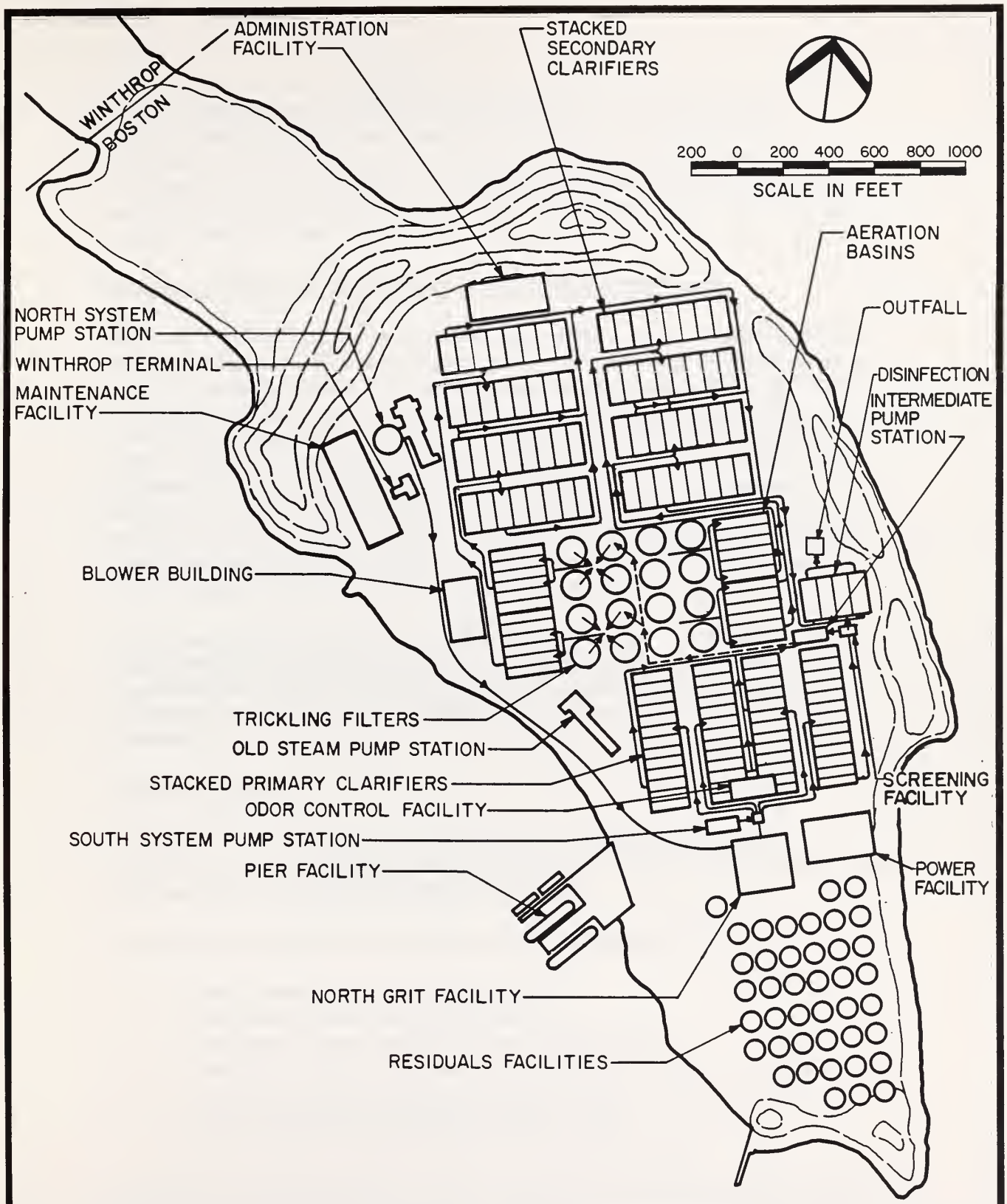


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**FIGURE 9.3.3-5**
**ALTERNATIVE IV: STACKED CLARIFIERS WITH COUPLED SYSTEM**

The area occupied by the trickling filters and aeration basins would be slightly larger than the area occupied by the air activated system in Alternative III. The trickling filters' hydraulic grade line would be approximately 20 feet higher than the aeration basins. Therefore, the trickling filters would be located on the highest portion of the drumlin. This would reduce the amount of excavation in this area in comparison to other alternatives. This alternative would also allow compliance with mitigation commitments and the goals set forth in the Harbor Perspective Report.

Deer Island Alternative V: Stacked Clarifiers With Oxygen Activated Sludge

Alternative V includes stacked primary and secondary clarifiers, oxygen activated sludge and disinfection. This layout is shown in Figure 9.3.3-6. The operation of the primary treatment plant is as described previously. The wastewater would exit the primary clarifiers and enter the secondary distribution box, where the flows would be distributed to the oxygen aeration basins. The operation of the aeration basins is similar to that of the activated sludge aeration basins, except that oxygen would be used instead of air. As with all of the previous alternatives, a battery of aeration basins would be connected to a battery of secondary clarifiers. The area for stacked secondary clarifiers for the oxygen process would be slightly larger than the area for stacked secondary clarifiers used for air activated sludge, due to the sizing criteria used for the oxygen system. The operation of the clarifiers and the transfer of flows, however, would be the same as above.

This alternative is, by a small margin, the most land efficient of all the alternatives. The oxygen aeration basins would occupy a smaller area than the air activated aeration basins. This is somewhat offset, though, by the increased area of the secondary clarifiers. Mitigation commitments and the berm concepts of the Harbor Perspective Report would be met by this alternative.

Vertical Plant Alignment

The elevation or vertical location of the treatment plant will also impact the ability to comply with goals and commitments. The plant's elevation is influenced by plant hydraulics and by the quantity of material to be excavated from the site.

The factors used to evaluate the plant's optimum elevation included the following:

- ease of constructing the treatment facility
- the amount of material that must be excavated
- the amount of excess material that must be disposed off-site
- the amount of structural fill needed below structures
- the pumping capabilities of the North System Pumping Station and Winthrop Terminal
- the head required for gravity operation of the outfall
- costs of constructing and operating an effluent pumping station

The possibility of eliminating effluent pumping is dependent upon having a hydraulic gradient sufficient to push the peak flow through the plant and outfall under storm conditions. Under peak flood tides, the plant will discharge against a seawater elevation of 117.5 ft. Allowing

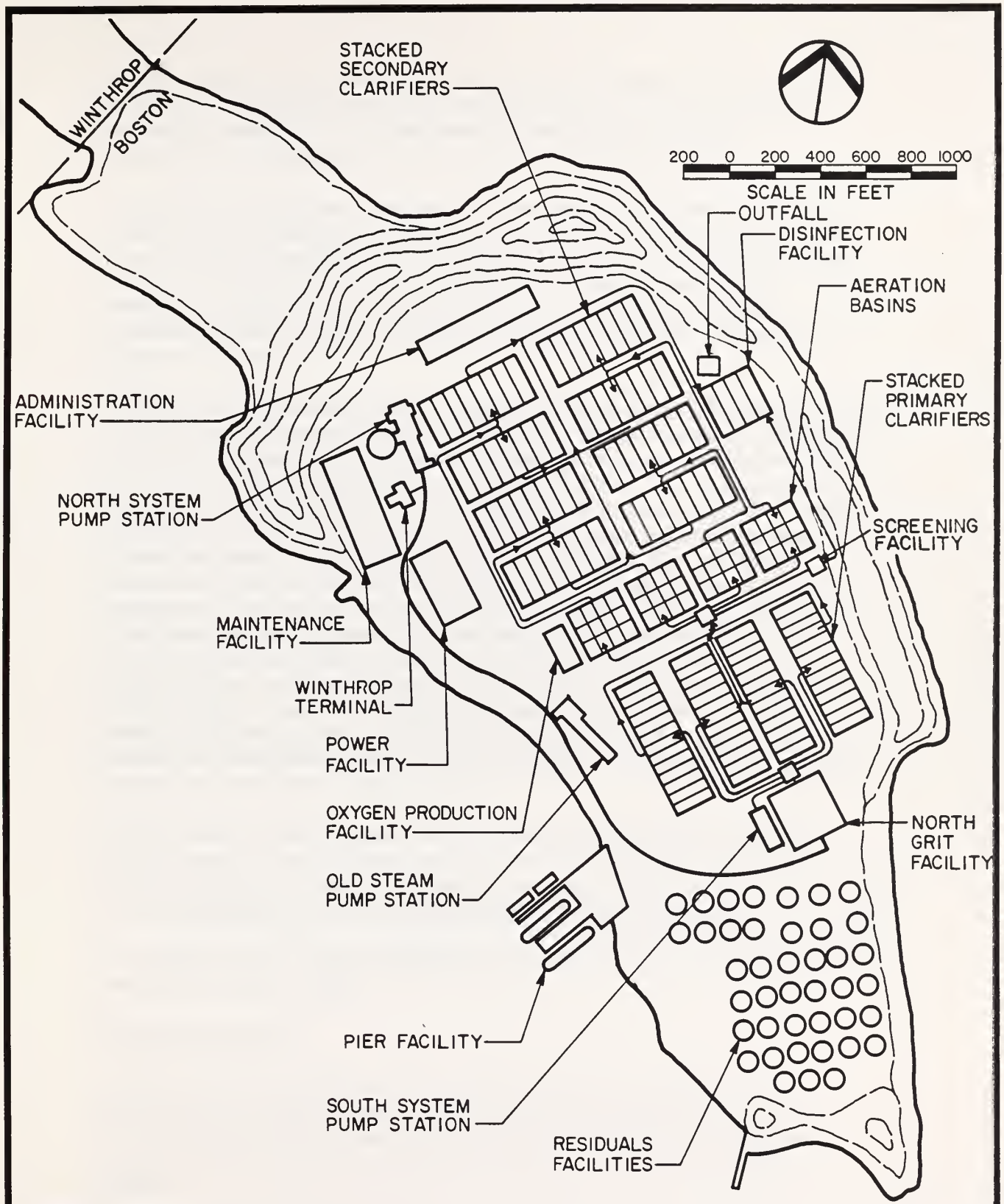


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**FIGURE 9.3.3-6**
**ALTERNATIVE V: STACKED CLARIFIERS WITH OXYGEN ACTIVATED SLUDGE**

for an 8-ft headloss in the outfall diffuser, and a 1 ft per mile headloss in the outfall together with a 16-ft headloss across the treatment facilities, would require a plant influent water surface elevation of 150.5 ft if the outfall is 9 miles long. This elevation is approximately 24 ft higher than the elevation of the existing primary clarifiers.

The second factor that influences the selection of plant elevation is the amount of excavated material that must be hauled off the island. The lower the hydraulic grade line (HGL), the greater the amount of excavation. As a representative example, the excavation for Alternative III, the air activated system with stacked clarifiers, was calculated for various HGL elevations from 135 ft to 155 ft. This information is shown graphically in Figure 9.3.3-7 and is presented as primary clarifier elevation versus volume of material to be excavated in millions of cubic yards.

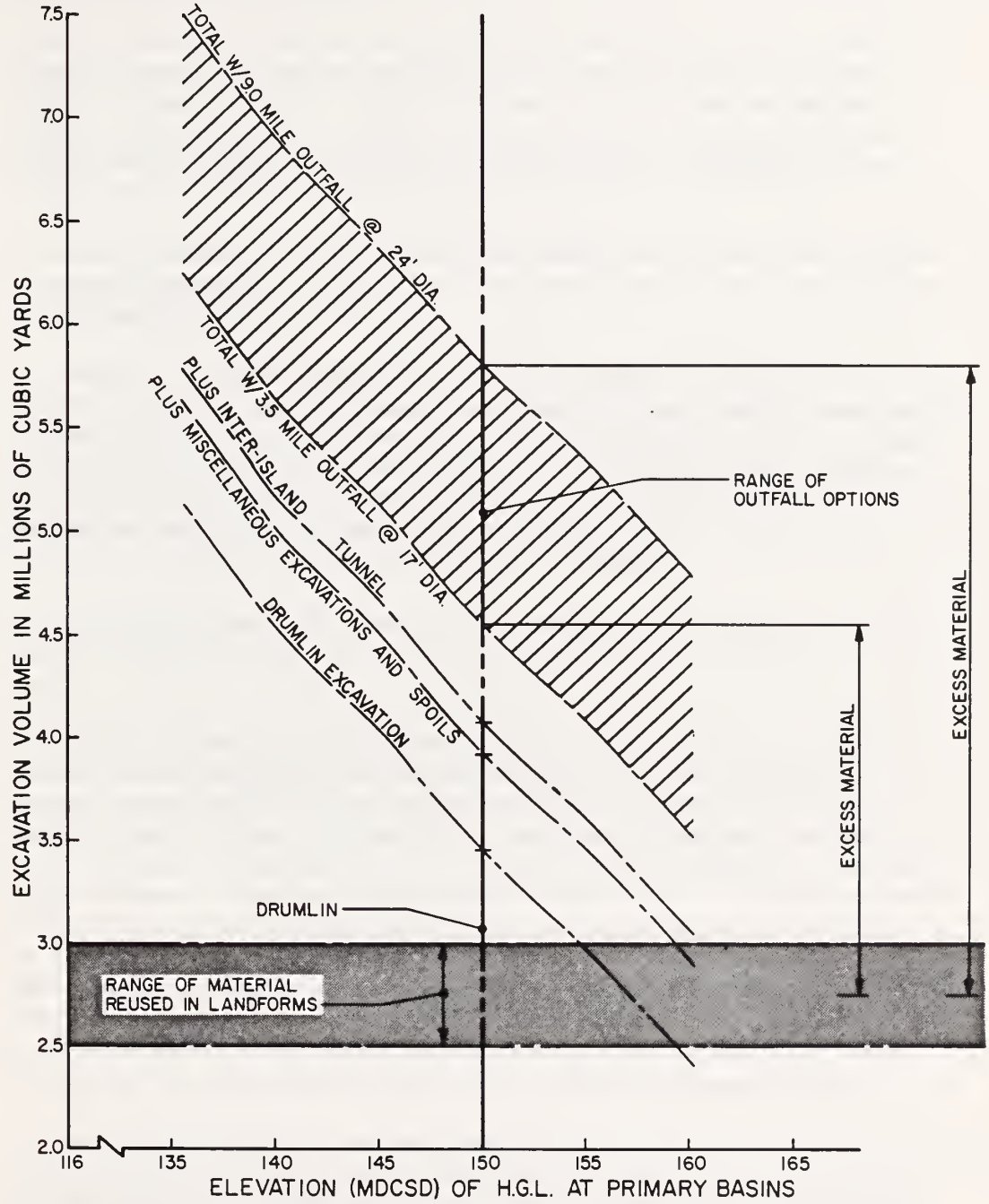
The graph shows the cumulative amount of materials to be excavated by several categories using the drumlin excavation as the base amount. The majority of on-site excavation is associated with the drumlin excavation, which varies significantly with changes in plant elevation ranging from over 5.0 million $yd^3$ at HGL 135, to 3.5 million $yd^3$ at HGL 150. In addition to the drumlin, there is other excavation that is not dependent upon the plant's HGL. This includes miscellaneous excavation of the bunkers and demolition of existing structures, excavation from the inter-island conduit, and the excavation from the outfall tunnel. The outfall tunnel excavation is depicted as a range of values reflecting the options being considered for the outfall location. Also shown on the graph is a range of material reuse which is representative of the material necessary to construct the berms on the site. At a plant elevation of 150 ft there is a total excavation ranging from 4.5 to 5.8 million $yd^3$ with a reuse of up to 3.0 million $yd^3$ on-site. As the plant's elevation is raised above a primary treatment HGL of 150, it becomes necessary to import structural fill for the southern end of the primary clarifiers, because, in this case, the bottom of the tanks would be above the natural grade. Also, since the plant HGL at the primary clarifiers exceeds this elevation, the facilities become much more prominent and more difficult to visually screen.

Vertically siting the primary treatment facilities in the elevation range between 150 ft and 155 ft eliminates the need for effluent pumping for the range of outfall lengths examined, effectively minimizes the amount of excavated material which must be removed from the site, and allows for compliance with the visual screening goals of the Harbor Perspective.

An analysis of costs for pumping indicated slight cost benefits in lifting the plant's HGL and eliminating the effluent pumping.

Process Related Facilities

In addition to the area and elevation requirements for process basins, there are other facilities that will be required in order to maintain an effectively operating treatment plant. These facilities are noted below and are addressed by type, size, purpose, and suggested location at the Deer Island Treatment Facility. The site layout figures include these facilities.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 9.3.3-7**
**ELEVATION OF PRIMARY CLARIFIERS VS VOLUME OF MATERIAL TO BE EXCAVATED**

Process-related buildings specific to certain alternatives include blower buildings, air control buildings, and pump stations.

A blower building with a superstructure of 27,000 $ft^2$ and approximately 40 feet in height is needed to house the equipment that will supply air flow to the air activated sludge aeration basins in Alternatives III and IV. This building would house the blowers and appurtenant equipment. This facility directly supports the aeration part of the treatment operation and, therefore, should be located within the area of the aeration basins. In particular, for ease in air distribution, it should be located centrally to the batteries of aeration basins.

In the case of Alternative IV, a trickling filter pump station would be needed. This would be a structure of approximately 15,000 $ft^2$, which would house pumps capable of lifting the flow into the trickling filters.

For Alternative V, a cryogeneration oxygen plant would be needed. This structure would be 42,000 $ft^2$ and would house the compressors and enclose the oxygen generation equipment. The cryogeneration facility manufactures pure oxygen, which would be then be fed to the oxygen modules in the oxygen activated sludge treatment process. This facility would be considered part of the treatment operation; therefore, it would be beneficial if this building were located within the area of the oxygen modules. It is preferable that it be centrally located for the ease of supplying oxygen to each battery of oxygen modules.

There are process-related facilities common to each alternative. These facilities are the odor and air emission control facilities, activated sludge pumping facilities, and north grit removal.

From preliminary studies, it appears that the grit removal, primary clarifiers, and aeration treatment processes will require covers and associated control facilities to mitigate air emission and odors from the treatment process. The types of air emission and odor control are reviewed in detail in Section 10.6. The size of a typical control facility varies with the air flow to be treated. Approximately 4,500 $ft^2$ is necessary for every 22,000 scfm to be treated. For this evaluation, air emission has been sized as modules of 4,500 $ft^2$. The modules consist of fans, scrubs, and carbon contact columns. Space has been allotted for a control facility at the grit facilities, and space for a control facility at each of the primary treatment batteries has been allocated as well. Because of the large air volumes at the air activated aeration basins, space for four control facilities has been allocated. Only one control facility is necessary for the oxygen activated aeration basins, due to the reduced air volumes. It is assumed that the location of the facility will be as close to the source as possible.

A Return Activated Sludge/Waste Activated Sludge (RAS/WAS) pump station will be needed for each battery of secondary clarifiers, to pump return activated sludge back to the aeration splitter box, and to pump waste activated sludge to the residual treatment process. The approximate size of the pump station is 5,500 $ft^2$ for each battery. The RAS/WAS pump facilities should be located in the vicinity of the secondary clarifiers. Options for location of RAS/WAS facilities include placement of the RAS/WAS facilities below grade in the space between batteries.

A North System grit removal facility is required. Alternatives evaluated include both Aerated Grit Chambers, which would require 40,000 $ft^2$, or Centrifugal Grit Chambers, which would also require 40,000 $ft^2$. The layouts depict 40,000 $ft^2$ area for grit removal.

For all alternatives, a South System pumping station structure is required. This facility would be approximately 132 ft by 80 ft and would be designed to pump flows from Nut Island through the inter-island conveyance system to primary treatment. Because this flow is being pumped, the location of the building would be independent of the primary process. However, it would be preferable to locate it in the area of the primary clarifiers to minimize the length of foremain.

All the treatment alternatives require power. Alternatives considered for power are either purchased power from off-site with an on-island distribution substation, on-site generation facilities, or a combination of all or part of both. The power option for both 100-percent off-site and the 100-percent on-site generation facilities are expected to require 70,000 square feet of area. Areas for both of these facilities have been shown in the layouts. They have been shown as being located between the treatment process and the residuals area. Other sites being considered are on the eastern shoreline, near the North Main Pumping Station. The location of the power facility is, however, independent of the treatment process, and these facilities could, subject to mitigation requirements, be located anywhere onsite.

Non-Process Related Facilities

The requirements for staffing and organization for the operation of the Deer Island Treatment Facility are detailed in Section 11.1.2. In summary, it is proposed that the facility operation be subdivided and be organized by specific operational areas. The operational areas are identified as follows: Main North System Pump Station; South Pump Station, North Grit Facility and Primary Clarification; Residuals; Aeration; Secondary Clarification; and Disinfection. In general, each operation facility is expected to have offices for the supervisory staff, employee lockers and sanitary facilities, and maintenance areas for minor on-site maintenance.

For each of these operational areas the required space is as follows:

| | |
|---|---|
| Main Pump Station | 6,100 $ft^2$ |
| South Pump Station etc. | 8,400 $ft^2$ |
| Residuals - (areas being developed in Residuals Management Facilities Plan) | -- |
| Aeration, etc. | 9,400 $ft^2$ |
| Total | 23,900 $ft^2$ |

It is important to locate these operational facilities close to the particular treatment operation. The location of the operation facilities and the ease of movement of personnel and vehicles to and from the various areas of treatment processes require that a transportation pathway be established as part of the layout. It is also expected that the operation areas

will be located as centrally as possible between the unit processes. It is expected that within the plant there will be tunnels or galleries located between the unit processes batteries. The transportation pathway within the plant should link the pier facilities with the operation centers; it should provide a pathway from equipment areas to the maintenance shop; and it should provide a pathway from the operations area to the administrative facilities.

The layouts include Maintenance Facilities consisting of repair shops, warehousing, vehicle maintenance, and dry storage for oversized items. The estimated area requirements total 137,000 $ft^2$. The repair shops are estimated to occupy 45,000 $ft^2$, and the warehousing 37,000 $ft^2$. Each of these facilities should be located on a single level with provisions for unhampered access from the pier and to the plant's internal transportation pathways. The repair shops are likely to be configured by trade (carpentry, painting, welding, machining) and access will be required to each of the trade areas. The vehicle maintenance is sized at 15,000 $ft^2$, and dry storage is 40,000 $ft^2$. Each of these facilities is two storeys in height.

The site layouts also include an Administration Facility and a Laboratory Facility. Space will be needed for administration, record keeping, a visitor center, and a laboratory. The management, senior supervisors, plant engineers, and clerical support staff will be housed in this facility. This building should be centrally located in relation to the operation areas, and should also be near the main transportation pathways associated with the pier facilities. The administrative functions require approximately 14,000 $ft^2$, and the laboratory requires 13,000 $ft^2$.

Personnel Facilities consisting of a first aid room, lunch room, locker rooms, and employee training rooms will be necessary. Approximately 12,000 $ft^2$ are required for these facilities. They should be convenient to both the piers and the operational areas for worker access.

Locations for these facilities are defined in Section 11.1. Many of these areas are shown on the alternative layouts herein. The location of most of these facilities on the alternative layouts has been provided as an indication of the space requirements necessary.

Construction Scheduling

The recommended alternative of stacked primary and secondary clarifiers in combination with an oxygen-activated sludge system will be constructed in phases, due to a combination of financial capability of the Authority and space limitations on the site. Since it is necessary to maintain the operation of the existing primary treatment facilities until such time as new primary treatment facilities are available, the first phase of construction will, of necessity, include a portion, if not all of the primary treatment facilities. The construction of the primary treatment facilities requires the simultaneous construction of several of the ancillary facilities such as power, potable water system, North System grit removal facilities, and modifications to the North System pumping facilities including the connecting forcemain. The recommended facilities have located all of these structures in areas that will have a minimum of interference with the existing plant's operations. Once a portion of the primary facility is constructed, then the construction of the remainder of the primary facilities can proceed, or a portion of the secondary facilities could be constructed.

Summary of Deer Island Alternative Site Layouts

The preparation of alternative site layouts results in two major recommendations. First, due to the site constraints, particularly with regard to area requirements, only alternatives with stacked clarifiers should be considered for detailed evaluation. Second, based on the need to minimize the volume of excavation, along with the desire to eliminate effluent pumping, an HGL elevation of 150 ft to 155 ft at the primary treatment facilities is recommended.

This section has also outlined the numerous other buildings that will be required for the operation of the facility. These other buildings will be located during the subsequent detailed evaluation and are shown in Section 11.1, Recommended Plan.

## 9.4 NUT ISLAND SITE PLANNING

The new headworks facility to be constructed at Nut Island will provide preliminary treatment to the South System flows prior to conveyance to Deer Island. The headworks will provide screening and grit removal and will contain mechanical bar screens, grit chambers, grit and screening handling facilities, and operations and administrative areas. Five site options for locating the headworks facility were screened through the Harbor Perspective process resulting in the selection of Sites A and D for detailed evaluation. Alternatives A and D were developed and evaluated within the context of site constraints, the site development goals established in the Harbor Perspective, and public opinion obtained from neighborhood meetings in Quincy.

### 9.4.1 DEVELOPMENT CONSTRAINTS AND GOALS

Site Constraints

Maintaining satisfactory operation of the existing treatment plant during construction places constraints on the siting alternatives for the new headworks facilities on Nut Island. These siting constraints are as follows:

- The existing grit and screening facilities must remain intact throughout construction and start-up of the new Nut Island headworks facilities.
- All of the primary clarifiers must remain operable.
- Disinfection must be continued throughout the construction and start-up period.
- The four anaerobic digesters may be taken out of service only if the interim residuals management program implemented by MWRA has the capability to accept raw sludge from Nut Island.
- The outfalls should continue to be used in their current manner throughout construction.

Site Development Goals

The goals of the headworks siting process are presented below:

- Construction activities immediately adjacent to the Hough's Neck residents should be minimized.
- Noise and air emission impacts should be mitigated by design.
- Visual impacts should be reduced as much as possible.
- A suitable environment should be provided for the headworks operations staff.
- Open space areas should be provided for passive, local, community-based recreational use.
- Pedestrian access to the perimeter of the island should be provided. Vehicular access to the northwest corner of the island, which would allow for viewing the harbor from vehicles, should be provided. Provisions for shoreline and scenic vantage points should be made, where possible.
- A clear separation between public areas and those occupied by the treatment facilities should be provided.

### 9.4.2 RECOMMENDED SITE ALTERNATIVE

The recommended location for the Nut Island headworks facility is at Site A. This site most closely meets the planning goals. Construction of the headworks facility cannot begin until interim residuals facilities with the capability of handling raw primary sludge are available. If these facilities are not available, then options would be to delay construction of the headworks facility 2-1/2 to 3 years until new residual facilities are available at Deer Island or to construct a headworks facility at Site D.

The cost of implementing each alternative is based on the respective siting conditions. The cost of constructing a headworks facility at Site A is $4.1 million less than at Site D. In addition to the costs directly related to construction, the costs of operating and maintaining the treatment plant during the headworks construction period must be accounted for. These costs are common to both alternatives except for the total costs of handling primary sludge over the time period covered by the interim residuals program. The cost difference between the interim residuals handling as required by the Site A alternative, versus handling digested sludge as allowed for under the Site D alternative, should be considered. At this time, these costs are not final.

# Section 10

# 10.0 DETAILED EVALUATION OF TREATMENT ALTERNATIVES

## 10.1 INTRODUCTION

This section presents a detailed evaluation of those treatment alternatives recommended in Section 8.0 for further evaluation. Alternatives are presented for accomplishing preliminary treatment, primary treatment, secondary treatment, disinfection and treatment of air emissions. The alternatives are compared using technical, environmental, institutional and cost considerations.

The engineering and cost estimates in this section were performed in early 1987 using preliminary estimates of flows and loads that are slightly different from the final estimates presented in Section 6.2 of this report. The flows and loads used in this section vary by only a few percent from the final flow and load estimates; therefore, the conclusions reached in this section are valid for the final flows and loads. However, the reader is cautioned that in the discussion of each treatment process in this section the preliminary flows and loads are presented. In Section 11.0, Recommended Facilities, the described facilities are based on the final flows and loads.

## 10.2 PRELIMINARY TREATMENT

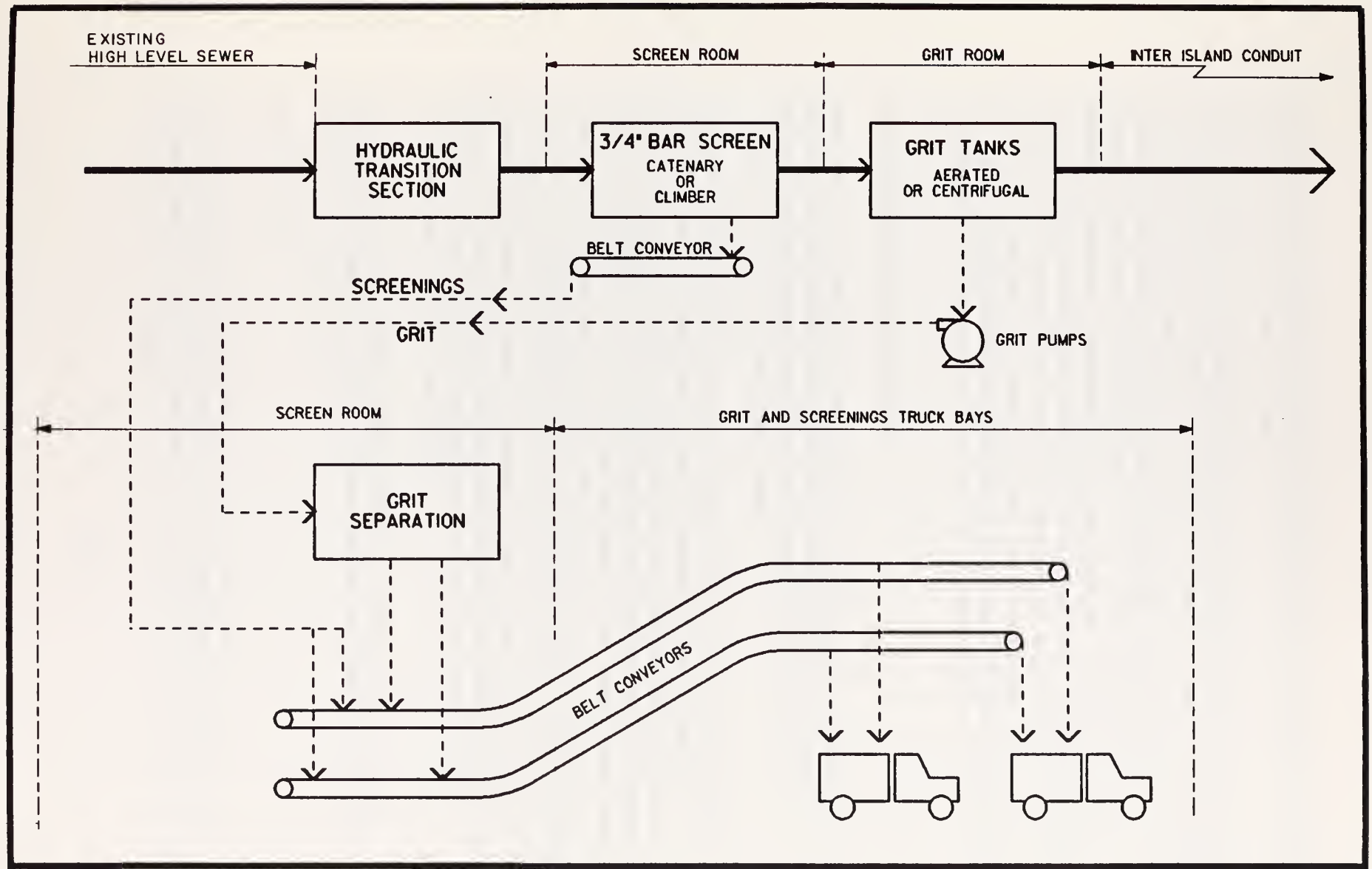
The purpose of this section is to present a description and evaluation of the preliminary treatment unit processes that have been evaluated in detail during the preparation of the Secondary Treatment Facilities Plan.

### 10.2.1 DESCRIPTION OF ALTERNATIVES

#### Nut Island Headworks Facility

Wastewater from MWRA's South System is currently treated at the Nut Island wastewater treatment plant. The treatment facilities include screening, grit removal, preaeration, primary sedimentation and disinfection. After start-up of the new Deer Island Secondary Treatment Facility, screening and grit removal for the South System flow will continue at a new Nut Island headworks facility. A schematic flow diagram of the new headworks facility is shown in Figure 10.2.1-1. Wastewater will then flow to Deer Island for primary and secondary treatment via a new inter-island conduit.

The first step in preliminary treatment at Nut Island is screening. The screening process removes rags, trash, and other large size solids that may interfere with the operation of such wastewater treatment equipment as gates, valves and pumps. Grit removal removes sand, gravel and other minute mineral matter, and organics such as seeds, shells, and coffee grounds. Removal of these materials protects moving mechanical equipment from abrasion and abnormal wear, and reduces quantities of grit that accumulate in conduits, channels and basins.




| | |
|---|---|
| MASSACHUSETTS WATER RESOURCES AUTHORITY | **FIGURE 10.2.1-1**<br>**NUT ISLAND**<br>**HEADWORKS FACILITY - FLOW SCHEMATIC** |

This section evaluates climber and catenary mechanical bar screens, and aerated and centrifugal grit removal systems, for use at Nut Island.

All of the preliminary unit processes evaluated were sized based on estimated maximum day flows that may be expected from the MWRA South System. The annual average daily flow for the design year of 2020 is 164 mgd, while the maximum day flow is 310 mgd. Screening and grit removal efficiencies are approximately the same for all of the alternative processes evaluated. Capacities, facility layouts and preliminary treatment unit process area requirements were established to determine the headworks facility's process and non-process space requirements for two site location options at Nut Island, as discussed in Section 9.0. The headworks siting and unit process options that were evaluated considered probable impacts from noise and odor, as well as visual aesthetics, the character of the land, and other impacts on the adjacent community. Also considered were constructibility of the headworks, operation of the existing Nut Island plant during construction and start-up of a new headworks facility, and site security.

Existing Preliminary Treatment Facilities

Rehabilitation of the existing Nut Island preliminary treatment facilities was evaluated as an alternative to the construction of a new preliminary treatment facility. The existing preliminary treatment facility consists of two 3/4-in-spaced catenary bar screens and six 10.5-ft-wide by 80-ft-long horizontal flow grit tanks.

Because of the relatively short length of the hydraulic transition section which connects the High Level Sewer to the treatment facility, and the resulting poor flow and velocity distributions throughout the facility, the screening and grit removal facilities are limited in their removal efficiencies. A new hydraulic transition section and screening facility would have to be constructed as part of a rehabilitation program. The new screening facility would include four 3/4-in-spaced mechanical bar screens to replace the two existing bar screens. A minimum of three additional similarly-sized grit tanks would be required to handle the 310 mgd flow, including a tank to satisfy redundancy requirements. The existing tank's dimensions and layout preclude effective conversion to an aerated grit removal system. The construction sequence for installing a new hydraulic transition section, a four-bay screening facility, and the addition of three new grit tanks, while maintaining existing plant operation during the construction phase, would be extremely difficult.

Salvaging and refitting the existing Nut Island preliminary treatment facilities was rejected as an alternative because of the difficulty of construction, and the difficulty in maintaining plant operations during construction.

Screening Facilities

Both of the screening unit processes evaluated require similar hydraulic transition sections and screening buildings. The basic difference in layout would be the configuration and the equipment required. The screening building area requirements are the same for both the climber and catenary bar screen alternatives.

Inlet Hydraulic Transition Section - The primary function of the hydraulic transition section is to convey wastewater from the horseshoe-shaped High Level Sewer to the screening building. An important criterion affecting the hydraulic section layout and configuration is that any two of the four screens must be capable of handling the peak flow of 310 mgd, as well as providing even flow distribution across the active screens. Also, consideration was given to the maintenance of a minimum velocity of 1.2 ft/sec in the screen bays to limit grit deposition and to minimize adverse debris-grit deposition under low flow conditions.

The hydraulic transition section will be designed to ensure that there is a free discharge from the high level sewer throughout the expected flow range.

Screening Facility Building - The screening building contains four mechanically cleaned bar screens, grit and screenings handling equipment, air emissions control facilities and non-process areas. The area of the screening building is approximately 19,000 $ft^2$. The screens, and grit and screening handling equipment are discussed later in this section. The non-process areas include a control room, electrical room, maintenance and spare parts room, lunch room, locker rooms, and office and reception areas. The screens and grit chambers will be housed or covered to provide a means of eliminating the discharge of volatile organic compounds (VOCs) and odors. The air above the water surface of the grit chambers and in the screening building process area will be treated by a two-stage system consisting of a wet scrubber with a packed tower followed by an activated carbon filter. The system will treat twelve air changes per hour. A more detailed description of air emission control is contained in Section 10.6.

Mechanical Bar Screens - An evaluation of the screening alternatives considered the use of a mechanically cleaned 3-in-spaced bar rack followed by a 3/4-in-spaced mechanical bar screen. Based on MWRA records and expected screening quantities for the non-combined sewer South System, the additional costs of the bar rack and enlarged screen building far outweigh the incremental protection afforded by a bar rack. In addition, the MWRA has removed the bar racks from the existing remote headworks which receive wastewater from the combined North System sewer. Coordination with the residuals facilities plan consultants has indicated that special handling of the screening material is not required. If compaction of screening material is considered at a later date, then evaluation of screenings compactors should be coupled with the re-evaluation of bar racks. Bar racks are required with screenings compactors to protect the compaction equipment.

The 3/4-in-spaced bar screen would be set at an angle of $80^\circ$ to the horizontal position. The nominal screen dimensions for both catenary and climber alternatives would be 11.5 ft wide and 10 ft deep for the expected water level at 310 mgd. The screens would be set in 11.5-ft-wide bays, approximately 40 ft long. Each of the four bays would have sluice gates at the entrance and exit to allow for isolation and dewatering of the bays. The screening room floor grade would be set three feet above the maximum expected level in the screen bays. In this case, a maximum wastewater velocity of 3 fps through 5/16-in-thick screen bars at the 310 mgd design flow was used to size the screen bay dimensions.

Catenary-and-climber-type mechanical bar screen cleaning mechanisms were evaluated. Both types

of screens have been installed and are satisfactorily operating in facilities of a size comparable to that of the proposed Nut Island Headworks Facility. One important feature common to both screen designs is that all important moving and rotating mechanical parts are above water. This allows for ease of inspection, maintenance, and repair work.

The catenary mechanical screen consists of a series of screen rake flights connected between two parallel chains which, in turn, are driven by a motor driven sprocket. The front cleaning screen rake moves down in front of the bar screen, guided by a curved guide frame located at the bottom of the bar screen. The rake flight is directed up along the bar screen rack to remove captured screenings. The screenings are then deposited onto a collection trough for handling and disposal.

The climber screen has a single screen rake and its movement is vertically controlled by a motor gear drive assembly attached to a rack and pinion gear frame. The climber rake enters in front of the bar screen and engages the bar rack as the rake reaches the bottom of the the bar screen. At this point the rake is retracked up along the screen to collect the screenings. Screenings are then deposited into a collection trough for handling and disposal.

A taller screening building may be required for the climber screen alternative, because it requires an additional 6 ft over the catenary screening alternative. For both bar screen alternatives, the mechanical cleaning would be automatically actuated, by either a timer or a pressure differential sensor which senses a pressure drop across the bar screen. The screenings removed from the bar screen would be collected and placed on a common 20-in-wide conveyer, which would transport them to truck loading bays. The screening conveyer system feed rate would be timed and sequenced automatically by the bar screen controller. At each mechanical screen, an emergency screening hopper cart would accept screenings in the event of failure of the conveyer system. The emergency hopper would be moved by an overhead crane system.

The truck loading garage consists of three drive-through truck bays at site grade. This allows one truck or container to be positioned in the loading garage to receive grit, one to receive screenings, and one to be available to receive grit or screenings on a stand-by basis. The conveyer system is arranged such that any one of three conveyers can transport grit or screenings to any one of the three truck bays.

Screening Quantities - The Nut Island Treatment Facility currently removes screenings at an approximate average annual rate of 0.9 $ft^3$/mil gal. Maximum day screening removal rates of up to 2.2 $ft^3$/mil gal have been experienced in recent years. As previously stated, flow distribution problems are known to cause excessive velocities through the existing bar screens and to cause unequal flow distribution to the screens. This would suggest that the screening records for the Nut Island Treatment Facility may underestimate the quantity of screenings received.

Screenings removal rates at other treatment plants in New England, and at large plants throughout the country, are predominantly in the 0.5 to 2 $ft^3$/mil gal range for separate collection systems. A 2 $ft^3$/mil gal removal rate, on an average annual basis, may be used as a

conservative estimate of performance. A volume of 12 $yd^3$ per day would be generated on an average annual basis. Using a peaking factor of 3.0 established in the Residuals Management Facilities Plan (1986), volumes up to 36 $yd^3$ may have to be handled.

Costs - Capital costs for the screening alternatives include the equipment and installation costs for the screens and instrumentation. The cost of four climber screens is $1,120,000 while the cost of the catenary screens is $650,000. Operation and maintenance expenses include salary and wages for operation and maintenance personnel, power costs, and equipment maintenance costs. The costs to operate and maintain the screens are not significantly different. Capital costs and operation and maintenance costs for screens are shown in Table 10.2.1-1.

Grit Removal Facilities

Following screening, wastewater is collected in a common channel and conveyed to the grit removal processes. The two alternative grit removal options under consideration at Nut Island are an aerated system and a centrifugal system.

Aerated Grit - The aerated grit removal system, consisting of four 23-ft-wide, 15-ft-deep side water by 85-ft-long grit tanks, is designed so that any three tanks will handle the 310 mgd design flow, with the fourth tank in reserve. The length of the aeration tanks was sized to provide a minimum 3-minute detention time at design flow. The grit tanks would remove 95% of grit material (specific gravity = 2.65) having a size greater than 0.3 mm.

Both the aerated and centrifugal systems use a helical motion to cause the grit material to concentrate and deposit along a preferred surface. The basic difference between the two systems is in the method of supplying the energy to maintain the helical motion in the grit tanks. In the aerated system, air under pressure is supplied along one side of the tank. The lifting action of the air causes the wastewater to form a helix along the tank. The grit is concentrated along the tank wall opposite the air supply and along the tank bottom by the centrifugal force of the helical motion and by gravity. The lighter organic solids are constantly being entrained by the relatively high turbulence level generated by the uniformly-spaced air diffusers along one of the tank walls. Air is supplied at 8 to 14 cubic feet per minute (cfm) per foot of tank length. Grit deposited along the transverse-sloping tank bottom is collected by a grit screw which runs the entire length of the tank. The grit is periodically pumped by a grit slurry pump to a grit concentrator cyclone and grit washing classifier. Grit is then placed on a 20-in-wide conveyer for transport to the truck loading bay. Effluent from the concentrator and classifier is discharged to the inter-island conduit.

Compressed air is supplied to the aerated grit tanks by five compressors. Three units operate at peak flow with one unit in reserve and one unit undergoing long-term maintenance. The compressors are connected to a common manifold followed by a service line to each tank diffuser line. The compressors are fitted with inlet and exit noise abatement silencers. The air emissions control facilities for the aerated system would be larger and more costly than

## TABLE 10.2.1-1
## NUT ISLAND SCREENING FACILITIES COSTS

### CAPITAL COSTS

| | Climber Screen Alternative | Catenary Screen Alternative |
|---|---|---|
| Equipment | $830,000 | $480,000 |
| Engineering and Contingencies | 290,000 | 170,000 |
| Totals | $1,120,000 | $650,000 |

### ANNUAL OPERATION AND MAINTENANCE COSTS

| | | |
|---|---|---|
| Salaries and Wages | $228,000 | $246,000 |
| Power | 2,000 | 2,000 |
| Equipment Maintenance | 8,000 | 10,000 |
| | $238,000 | $258,000 |

the facility required for the centrifugal system because of the larger air volume of the grit building.

The aerated grit chambers are enclosed in order to control air emissions, noise, and visual impacts. The structure is only large enough to allow proper access for maintenance and the installation and removal of equipment. The structure covers approximately 7,000 $ft^2$.

Table 10.2.1-2 summarizes the sizing criteria and equipment required for the aerated grit removal system.

Centrifugal Grit - The centrifugal grit removal system layout consists of six 24-ft-diameter grit tanks. Under peak flow conditions, five tanks will be operating with the sixth tank held in reserve. Removal of grit is accomplished by a centrifugal action in conjunction with gravity. The centrifugal action, induced by tangentially introducing water to the circular chamber, moves the grit down and to the outside of the chamber. A rotating paddle creates a water pattern that moves the grit to a collection hopper at the center of the chamber and resuspends the lighter organic particles. The effluent leaves the grit chamber near the top of the chamber via an overflow weir to a conduit which is connected to the inter-island conduit for transport to Deer Island.

The grit would be pumped periodically from the grit collection hopper to the grit cyclone/classifier by grit slurry pumps located above the chamber. Two grit pumps are provided for each chamber, one of which serves as backup. The dewatered and washed grit would be transported by conveyer to the truck loading area. The grit removal and handling systems are similar for both the centrifugal and aerated alternatives.

Enclosing the centrifugal grit chambers in order to control air emissions, noise, and visual impacts requires a structure that is smaller than that required for the aerated grit chambers, because the mechanical equipment used in the centrifugal process is smaller. Access to the centrifugal grit tanks from the screening building would be via a series of interconnected 6-ft-wide by 7.5-ft-high tunnels located over the chamber influent channels. The circular tanks would be covered by a concrete slab with additional access to each tank by an overhead hatch. A stairway would also be provided to meet building code requirements. The area of the structure would be approximately 4700 $ft^3$. The sizing criteria and equipment required for the alternative centrifugal grit removal system are also summarized on Table 10.2.1-2.

Grit Quantities - The grit chambers at Nut Island currently remove grit at an average annual rate of approximately 0.8 $ft^3$ per million gallons. Significant quantities of grit are known to deposit in the primary sedimentation basins and digesters. Therefore, the current grit removal rates most likely underestimate the grit loadings. Grit removal rates of treatment plants contacted in New England and throughout the country range from 1 to 3 $ft^3$/mg. For the new facilities, a removal rate of 2.0 $ft^3$/mg was used. This rate is conservative for a separate collection system such as the South System. A volume of 12 $yd^3$ would be generated on an average day. Using the peaking factor of 3.0 established in the Residuals Management Facilities Plan (1986), volumes up to 36 $yd^3$ may have to be handled. The grit and screening quantities are summarized for all headworks facilities including Nut Island in Table 10.2.1-5.

## TABLE 10.2.1-2
## NUT ISLAND GRIT REMOVAL SIZING CRITERIA

**AERATED GRIT CHAMBERS**

**Tanks**

| | |
|---|---|
| Number (includes one standby tank) | 4 |
| Size | |
| Length | 25 ft |
| Depth | 23 ft |
| Capacity | 104 mgd |
| Detention Time at peak flow | 3 min |
| Air Supply | 8 to 14 cfm per linear ft |
| Capture efficiency | 95% material size > 0.3 mm, Specific gravity - Sp Gr of 2.65 |

**Slurry Pumps**

| | |
|---|---|
| Number (including standby) | 8 |
| Capacity | 150-200 gpm at 30 ft tdh |
| Horsepower | 5 hp |

**CENTRIFUGAL GRIT CHAMBER**

**Tanks**

| | |
|---|---|
| Number (includes one standby tank) | 6 |
| Size | 24 ft diameter |
| Capacity | 70 mgd |

**Slurry Pumps**

| | |
|---|---|
| Number (including standby) | 12 |
| Capacity | 150-200 gpm, 30 ft tdh |
| Horsepower | 5 hp |

Costs - Capital costs for the aerated and centrifugal grit chambers are presented in Table 10.2.1-3. Nut Island grit chamber structure costs cover materials excavation, backfilling and dewatering. Equipment costs include screw conveyers, compressors, and air diffusers for the aerated alternative; paddles and motors for the centrifugal alternative; and grit pumps, grit concentrators and grit washers for both alternatives.

Operation and maintenance costs are also presented in Table 10.2.1-3. These costs include salaries and wages for operation and maintenance personnel, power costs and equipment maintenance costs. The equipment and maintenance costs reflect the relatively frequent equipment replacement and maintenance typical for this type of process.

North System Headworks Facilities

This section describes modifications to the existing North System headworks facilities that are being undertaken under the MWRA's fast-track improvements program, and the alternative new headworks facility located on Deer Island.

Winthrop Terminal Headworks

The Winthrop Terminal, located on Deer Island, receives wastewater from the North Metropolitan Trunk Sewer, screens the wastewater, and lifts the flow into existing grit chambers. The wastewater then flows by gravity to the existing primary treatment plant. The design flows through the trunk sewer and the Winthrop Terminal range from 21 to 125 mgd, with an average flow of 29 mgd.

The Winthrop Terminal is currently undergoing major modifications as part of the fast track improvements program. At the completion of this program, the Winthrop Terminal will house six wastewater pumps and three screens. Four pumps will be rated at 23 mgd at 38 ft total dynamic head (tdh); two pumps will be rated at 46 mgd at 33 ft tdh. All six pumps will be driven by variable-speed electric motor drives. Three mechanically cleaned climber-type screens will each be capable of screening 62.5 mgd, or one-half the maximum design flow. Refer to Section 5.1.2 for a complete description of the existing conditions and the proposed fast-track improvements.

Construction of new secondary treatment facilities at Deer Island will necessitate the conveyance of wastewater from the North Metropolitan Trunk Sewer to new North System grit removal facilities. The water surface elevation in the new grit chamber will be 158 ft. which is approximately 30 ft higher than the water surface elevation in the existing grit chambers. Because of this, the pumps in the Winthrop Terminal will have insufficient head to pump the design flow to the new treatment facilities.

To meet future hydraulic conditions, two alternatives were evaluated. One alternative was to modify the existing Winthrop Terminal. while the other alternative was to construct a new facility.

**TABLE 10.2.1-3**

**NUT ISLAND GRIT REMOVAL COSTS**

**CAPITAL COSTS**

| | Aerated | Centrifugal |
|---|---|---|
| Structures | $1,920,000 | $1,070,000 |
| Equipment | 1,010,000 | 710,000 |
| Engineering and Contingencies | 1,030,000 | 620,000 |
| TOTALS | $3,960,000 | $2,400,000 |

**ANNUAL OPERATION AND MAINTENANCE COSTS**

| | | |
|---|---|---|
| Salaries and Wages | $290,000 | $280,000 |
| Power | 70,000 | 10,000 |
| Equipment Maintenance | 50,000 | 40,000 |
| TOTALS | $410,000 | $330,000 |

Modified Winthrop Terminal. Modifications of the existing Winthrop Terminal to pump from the North Metropolitan Trunk Sewer to the new treatment facilities would include replacement of all six pump units, including electric motor and variable-speed drives, and the addition of new piping, valves, electrical switchgear, and controls.

The new schematic flow diagram and the hydraulic profile are shown in Figures 10.2.1-2 and 10.2.1-3, respectively. As shown on the profile, the required maximum pump tdh is 80 ft. At the peak design flow of 125 mgd, four pumps would be required to operate. The pump system head curve for all flows in this system is shown in Figure 10.2.1-4. Plans and sections of the modified facility are shown in Figures 10.2.1-5 and 10.2.1-6.

To meet the new operating conditions, six new pumps, each rated at 32 mgd at 80 ft tdh, would be installed. At the peak design flow of 125 mgd, four pumps would operate, leaving two pumps on standby. The design criteria discussed in Section 4.0 call for two backup pumps for every three operating pumps at peak flow. Strict adherence to this criterion is not practical for the Winthrop Terminal. Six pumps were selected because the existing facility is arranged for this number; 32-mgd pumps were selected because they are better suited than larger pumps for handling the average flow of 29 mgd. Also, these pumps will discharge wastewater into two force mains for conveyance to the new grit chambers. In order to split the flow, it is desirable to have an even number of pumps operating at peak flow.

New 600-hp electric motors and variable-speed drives would be installed with each of the new pumps. Also, new electrical switchgear, motor starters, controls, and cable would be required. Variable-speed drives are required to effectively handle the wide range of design flows.

As shown in Figures 10.2.1-2 and 10.2.1-6, major piping modifications are also required. For pumps 1, 2, 5, and 6, new suction piping and knife gate valves and new discharge piping, butterfly valves, flow elements, and knife gate valves would be required. For pumps 3 and 4, new discharge piping, butterfly valves, flow elements, and knife gate valves would be required.

A new knife gate valve would be installed in each pump discharge line. As shown by the hydraulic profile in Figure 10.2.1-3, the entire piping system downstream of the pumps is under pressure. This valve would provide a means of removing the flow element or the butterfly valve from the pump discharge line and would provide backup isolating support to the butterfly valve when a pump is removed for maintenance.

The three mechanically-cleaned climber screens being installed as part of the fast-track program would be utilized. At the peak design flow of 125 mgd, two screens would operate, leaving one screen on standby. The design criteria discussed in Section 4.0 call for two backup screens for every three operating screens at peak flow. Strict adherence to this criterion is not practical for the Winthrop Terminal modification because the existing

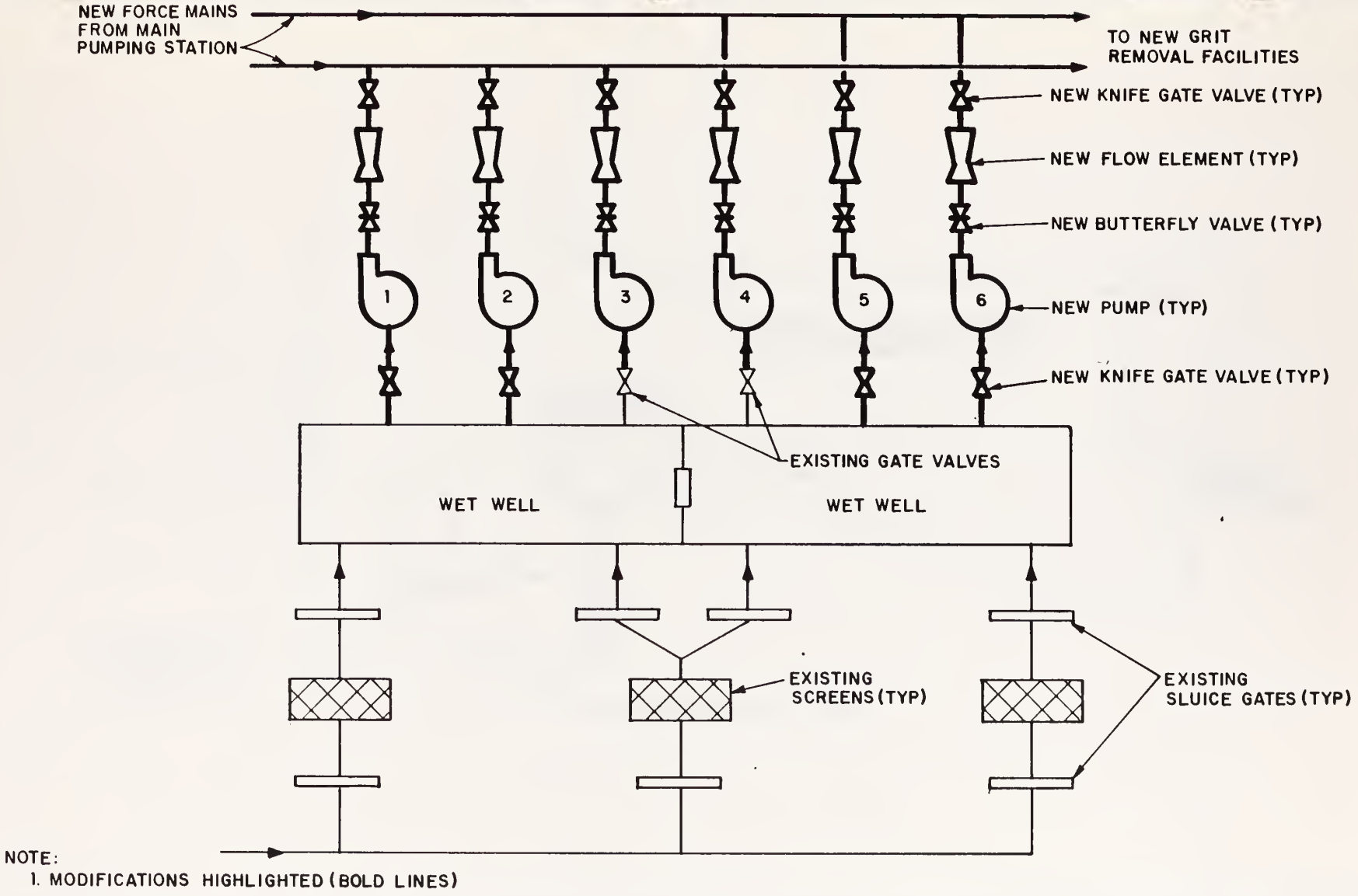



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**FIGURE 10.2.1-2**
**MODIFIED WINTHROP TERMINAL FACILITIES FLOW DIAGRAM**

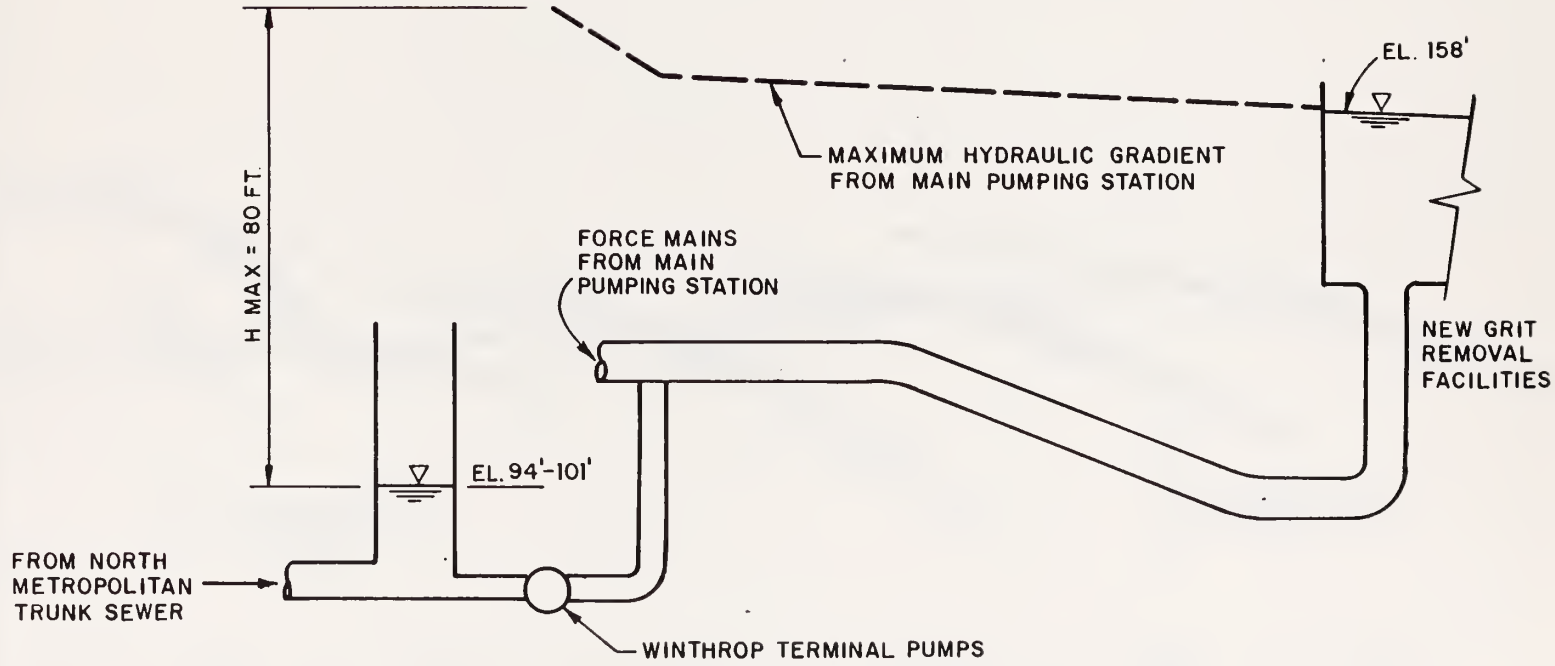


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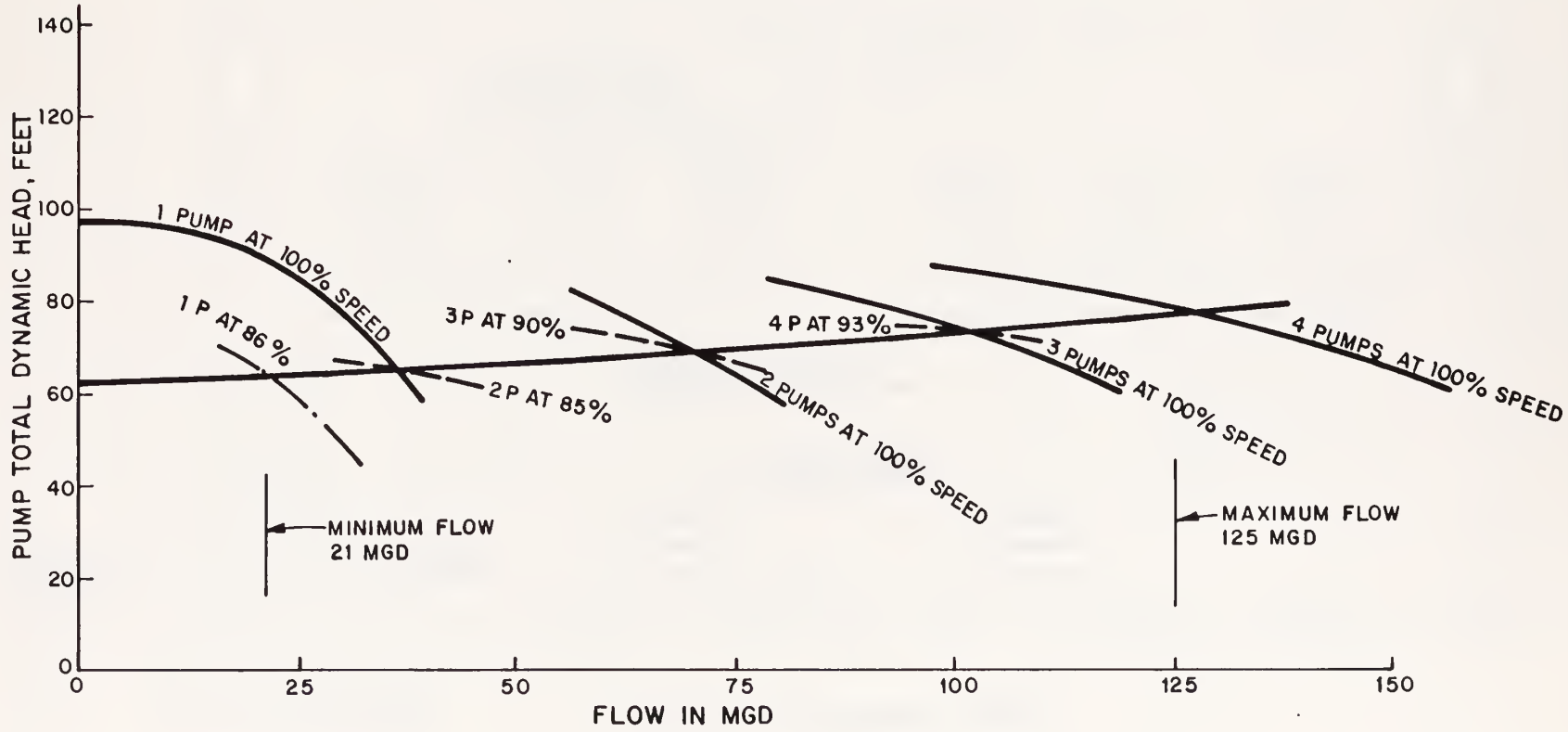
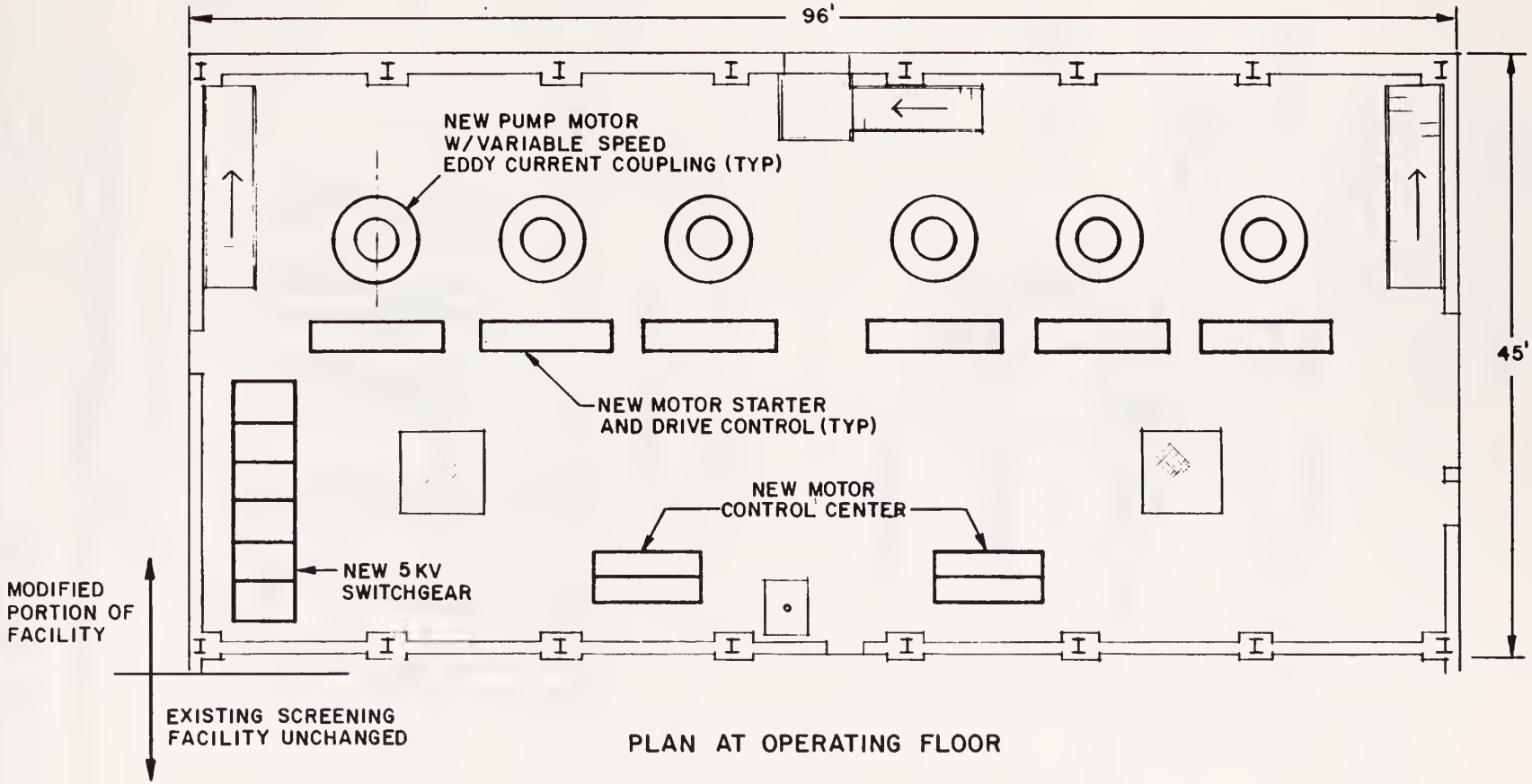
**FIGURE 10.2.1-3**
**HYDRAULIC PROFILE**
**WINTHROP TERMINAL TO NEW TREATMENT FACILITIES**



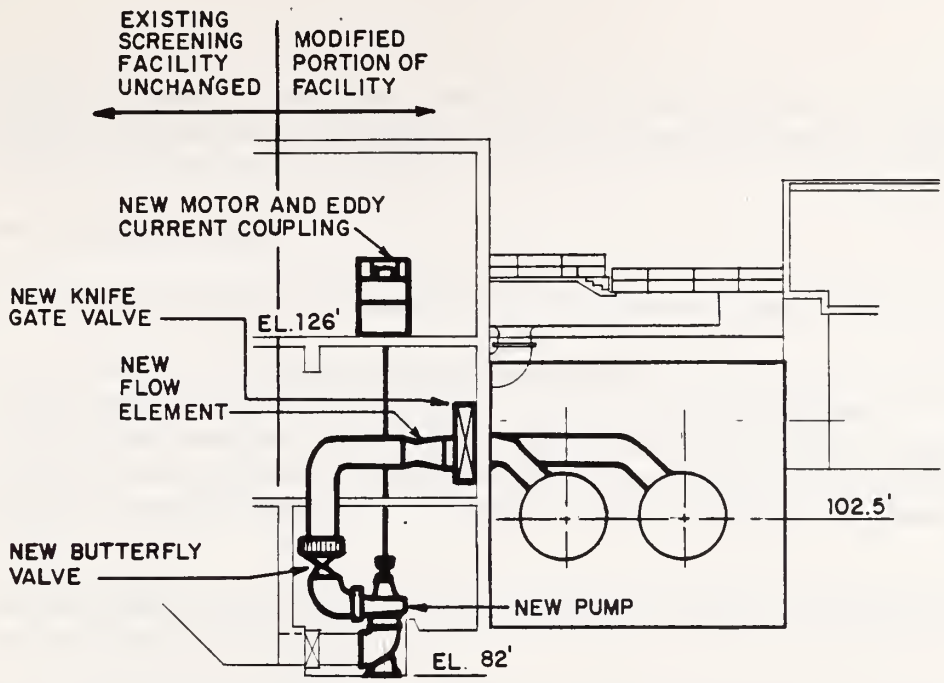

| | |
|---|---|
| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 10.2.1-4<br>PUMP OPERATING MODES<br>MODIFIED WINTHROP TERMINAL |



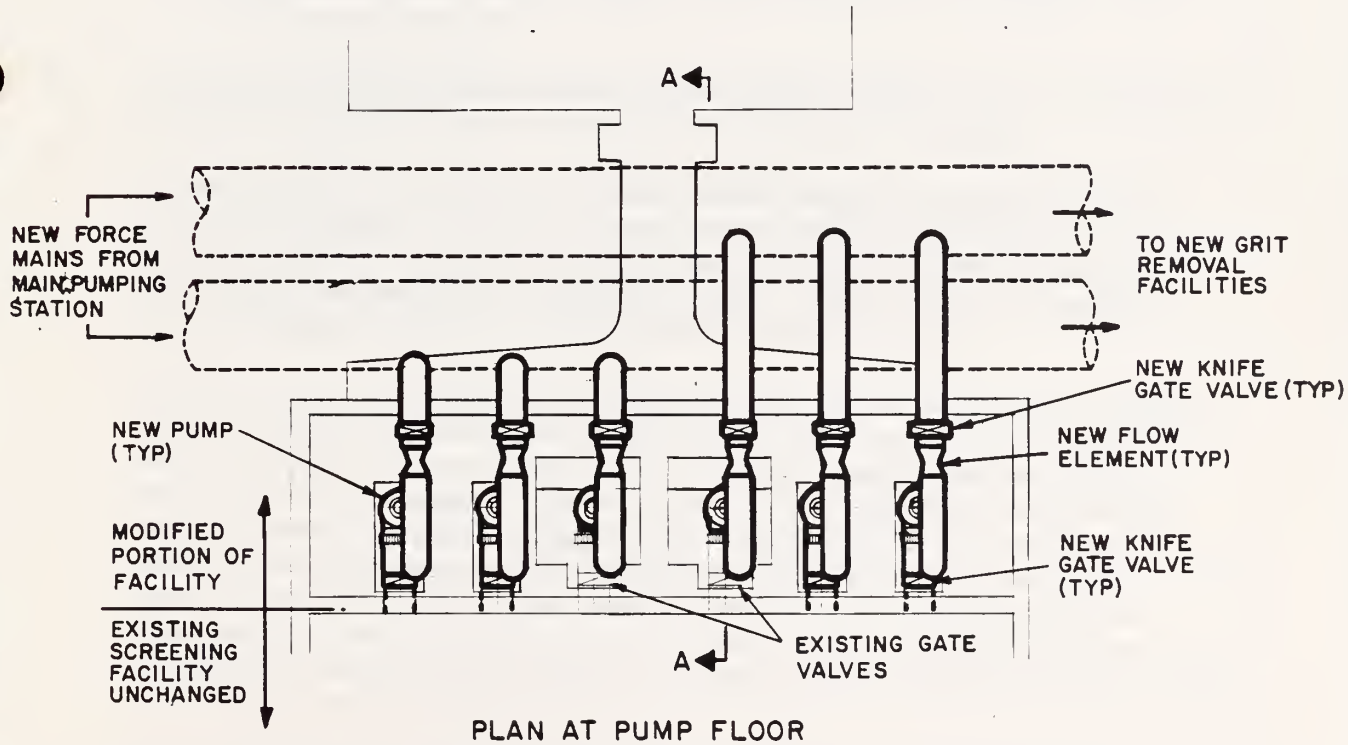

NOTES:
1. MODIFICATIONS HIGHLIGHTED (BOLD LINES)

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 10.2.1-5**
**MODIFIED WINTHROP TERMINAL FACILITIES**




SECTION A-A




PLAN AT PUMP FLOOR

NOTE: 1. MODIFICATIONS HIGHLIGHTED (BOLD LINES)

| | |
|---|---|
| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 10.2.1-6<br>MODIFIED WINTHROP TERMINAL FACILITIES |

structure is arranged for three screens, each rated at 62.5 mgd. However, this is acceptable because the average flow is only 29 mgd, and only one screen will normally be required to operate, leaving two screens on standby.

New Winthrop Terminal

The alternative to modifying the existing Winthrop Terminal is to construct a new facility.

The new Winthrop Terminal would be constructed adjacent to the South System Pumping Station in order to consolidate all new pumping facilities in one area. This would facilitate construction and operations. Wastewater currently enters the existing Winthrop Terminal from the 108-in-diameter North Metropolitan Trunk Sewer. It would be necessary to extend the trunk sewer from the existing facility to the new Winthrop Terminal, a distance of approximately 2,500 ft.

The new Winthrop Terminal would be similar to design to the modified facility described above, with the following major exceptions:

- Four (instead of three) mechanically-cleaned climber screens, each rated at 62.5 mgd, would be installed

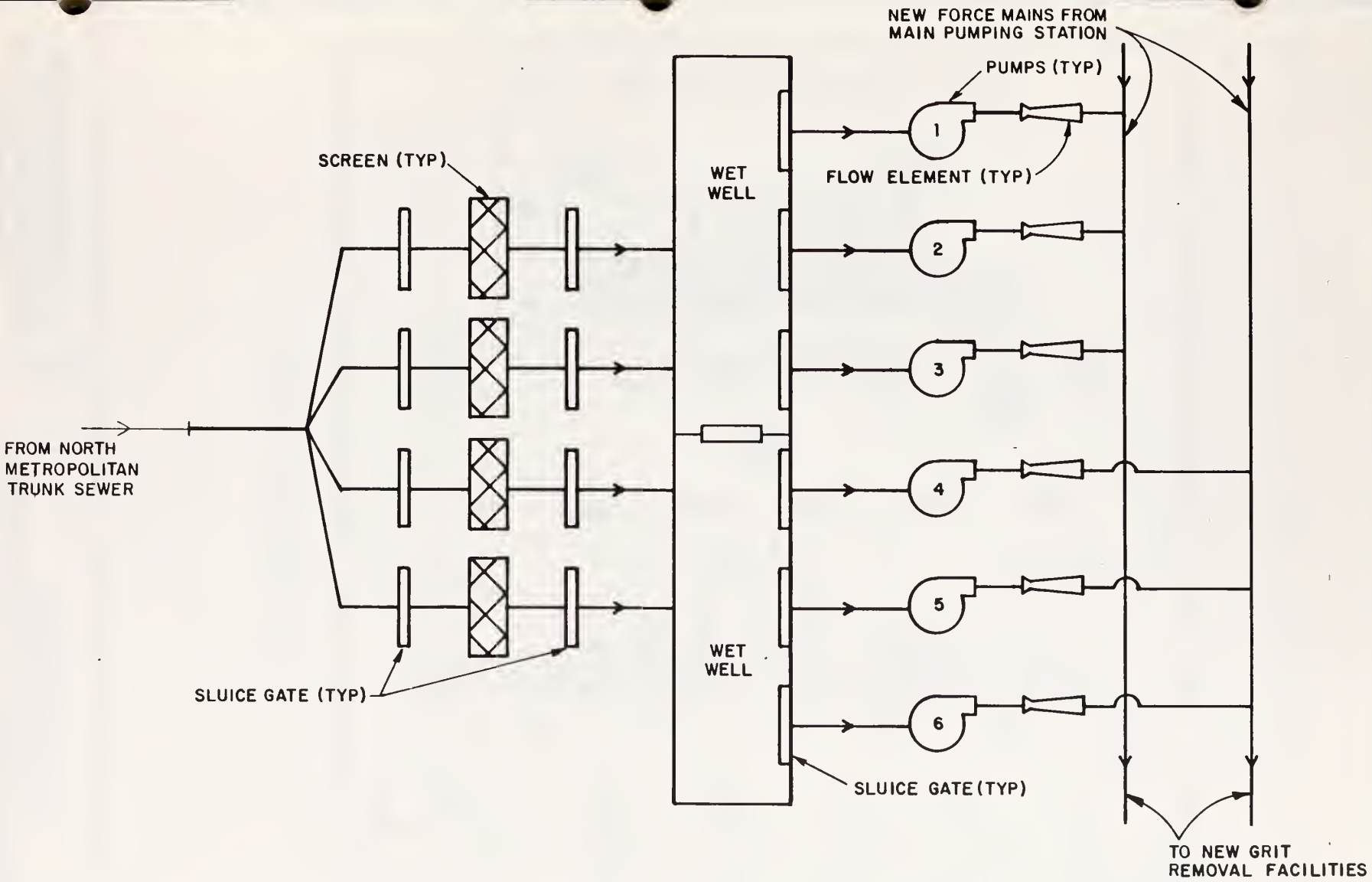
- Pump discharge piping would be designed with loop seals (instead of knife gate valves) in order to simplify operations

A schematic flow diagram of the Winthrop Terminal is shown in Figure 10.2.1-7, and plans and sections of the facility are shown in Figures 10.2.1-8 and 10.2.1-9, respectively.

The design criteria in Section 4.0 call for three screens to operate at peak design flow with two screens on standby. By using the three new climber screens being installed in the existing Winthrop Terminal as part of the fast-track program, this criterion would be satisfied by installing one additional screen for a total of four screens. Only two screens are required to operate at the peak design flow of 125 mgd, leaving two screens on standby.

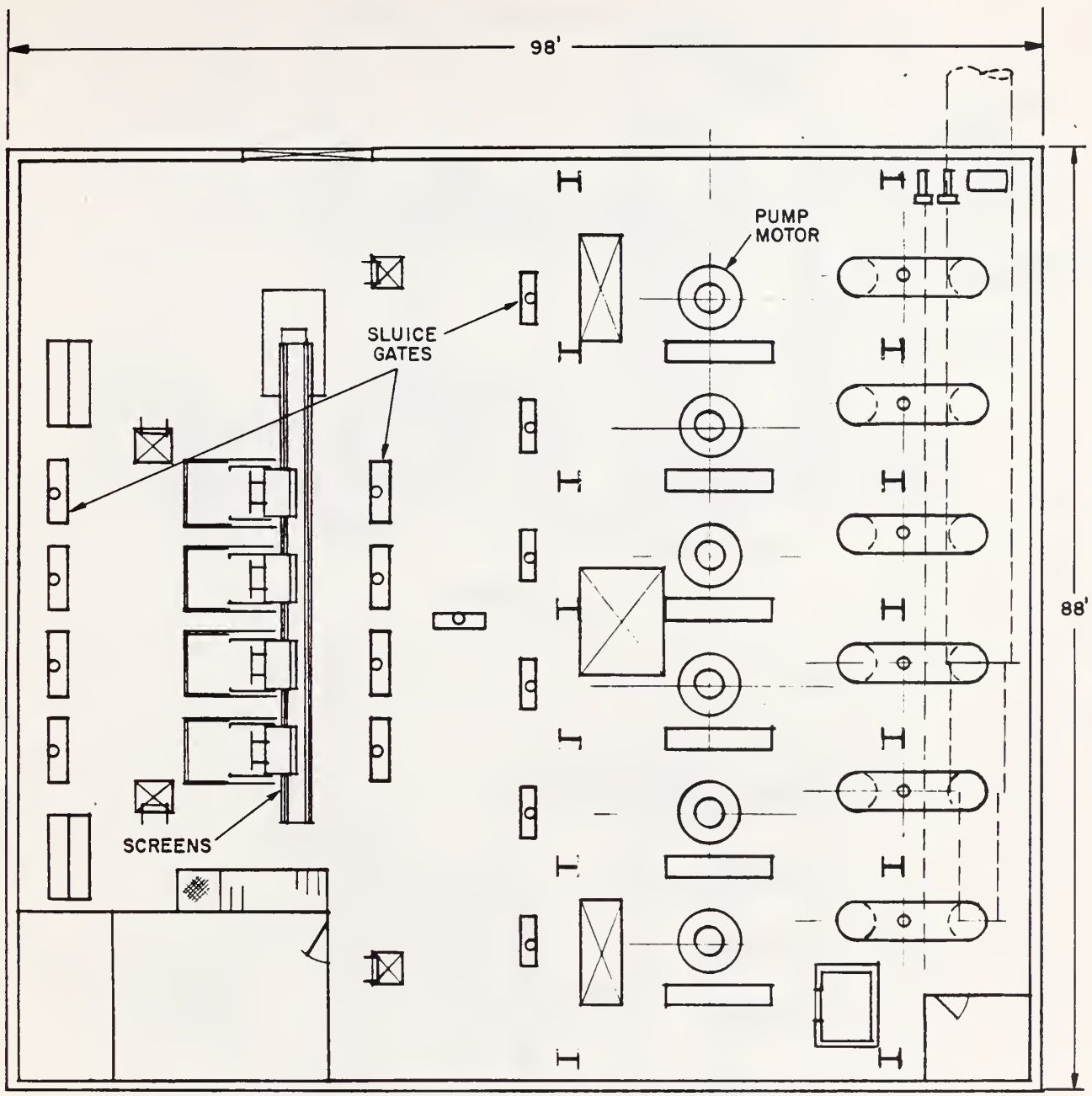
Six pumps would pump wastewater from the station wetwell to the new Deer Island grit removal facilities. The pumps are sized so that four pumps would be adequate to pump the peak design flow. This provides two spares, allowing one to be on ready standby in the event that the other is down for maintenance. The pumps are of the vertical-shaft, dry-pit, mixed-flow type. Based on preliminary hydraulic analysis, six installed pumps would be the minimum needed for efficient operation throughout the wide range of design flows. Also, these pumps would discharge wastewater into the two force mains originating at the Main Pumping Station and terminating at the new grit chambers. In order to split the flow, it is desirable to have an even number of pumps operating at peak flow. The pump operating modes for all flows would be similar to those shown in Figure 10.2.1-4.

The pumps would be set to provide adequate submergence below the minimum expected wetwell water surface. The motor drives would be located on the operating floor. Each pump would discharge




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

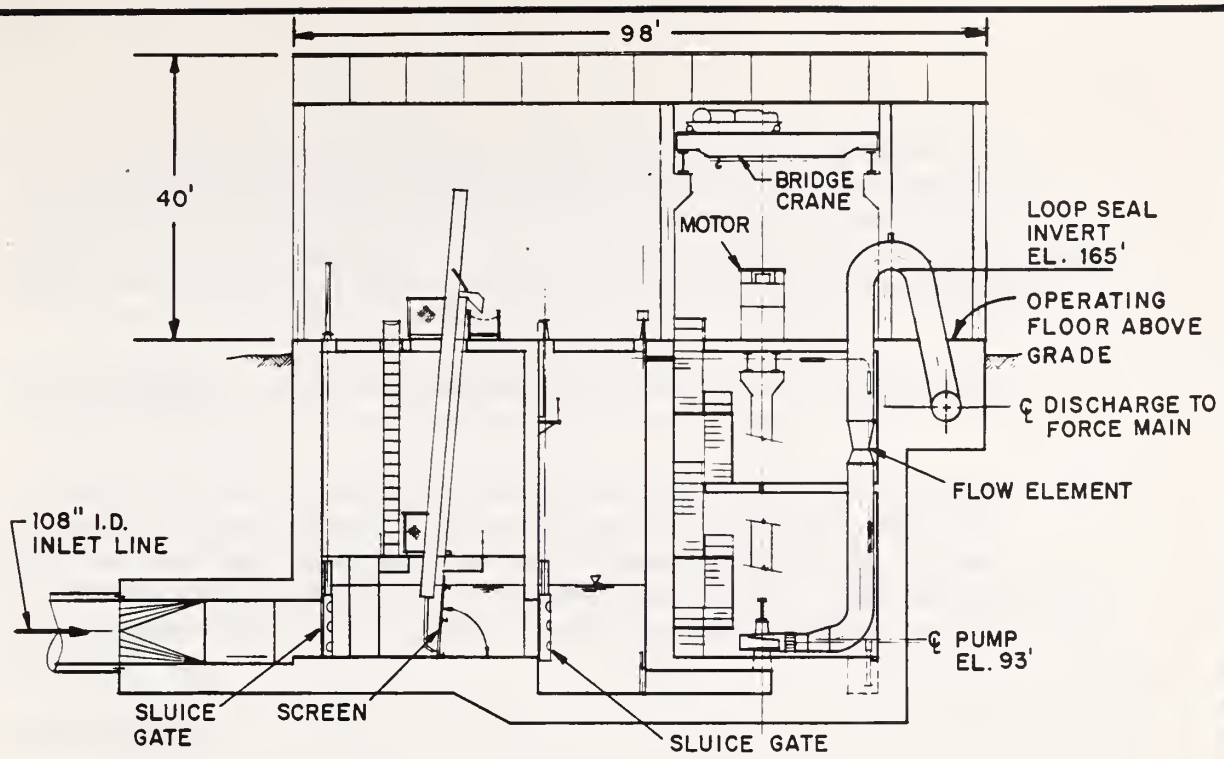
**FIGURE 10.2.1-7**
**NEW WINTHROP TERMINAL FACILITIES**
**FLOW DIAGRAM**



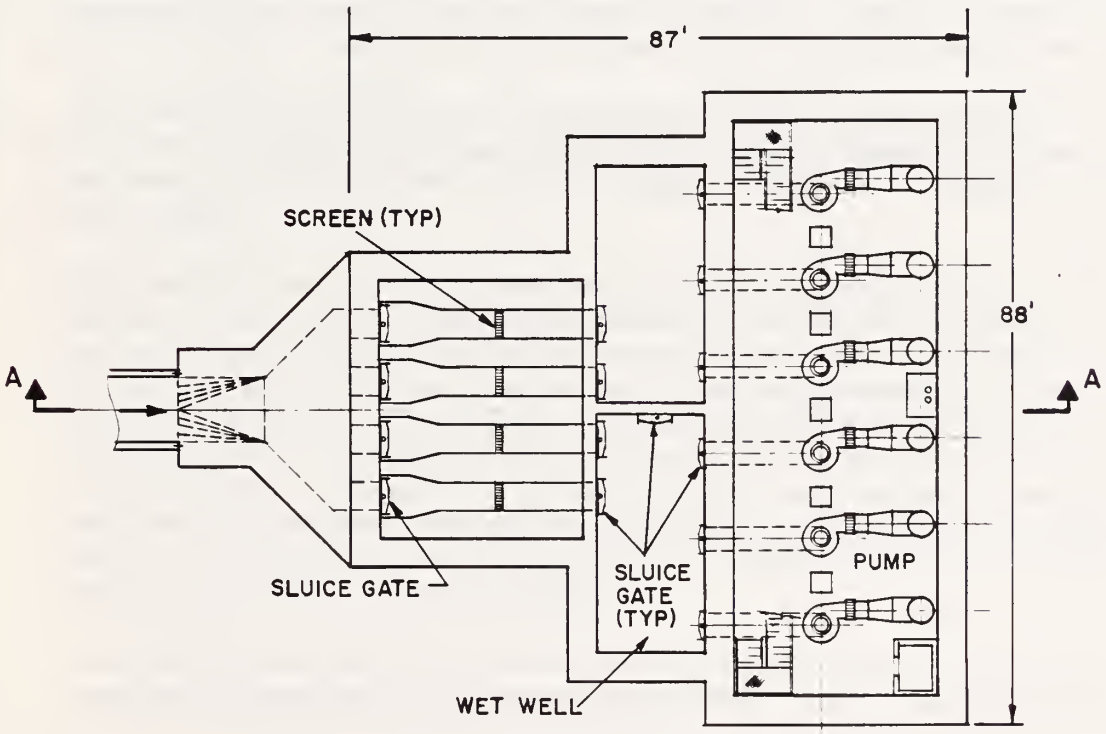

PLAN AT OPERATING FLOOR

MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 10.2.1-8
NEW WINTHROP TERMINAL FACILITIES




SECTION A-A




PLAN AT PUMP FLOOR

MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 10.2.1-9**
**NEW WINTHROP TERMINAL FACILITIES**

into an individual vertical riser containing a loop seal with an invert at approximately elev. 165 ft, thus providing an adequate margin against backflow from the treatment facilities. If a pump is shut down or fails, the vacuum would be broken at the top of the loop seal by the automatic opening of an air inlet valve. This would ensure that backflow through the down pump does not exceed the volume contained in the riser pipe. The loop seal with air-inlet valve was chosen over a knife gate valve in the discharge line because of its simplicity.

Cost Comparisons. Cost estimates were prepared for each of the two Winthrop Terminal alternatives. Table 10.2.1-4 presents the results of the cost evaluation.

As presented in this table, present worth cost is the sum of all costs required to construct and operate the system, presented as an equivalent single initial investment. Project cost represents the estimated capital construction cost in September 1986 dollars and includes a 25-percent allowance for engineering and contingency costs. Annual operation and maintenance cost is the average annual cost to operate and maintain the system and includes the cost of power.

Remote Headworks

The Chelsea Creek, Columbus Park and Ward Street remote headworks installations currently provide preliminary treatment, which includes screening and grit removal, for wastewater transported to Deer Island, excluding the Winthrop Terminal flows. While each remote headworks facility has a different capacity, they are very similar in physical layout and unit processes.

Fast-track improvements to each of the remote headworks facilities include installing new climber-type mechanically cleaned bar screens (3/4-in bar spacing), replacing most of the equipment in the headworks facility with similar equipment, and adding new ventilation and odor control systems.

High efficiency horizontal flow grit channels are normally sized to limit the velocities in the grit tanks to less than 1 fps. Wastewater flow velocities at the existing remote headworks facilities are known to exceed 1 fps. This is the main reason that significant quantities of grit can be expected to reach Deer Island even after the fast-track improvements have been made. Removal rates for grit and screenings at the existing headworks for the years 1973 to 1983 are presented in Table 10.2.1-5. It is anticipated that the removal efficiency will improve by as much as fifty percent for both the grit chambers and screens once the fast-track improvements are completed. Additional grit washing equipment was considered at the remote headworks; however, the minimal additional benefit over the existing grit removal and washing system does not justify new grit washing facilities.

The improved remote headworks will provide adequate protection from grit deposition for the wastewater conveyance tunnels throughout the planning period. However, additional grit removal

**TABLE 10.2.1-4**

**COST EVALUATION OF WINTHROP TERMINAL ALTERNATIVES**
(in millions of dollars)

| | Modified Winthrop Terminal | New Winthrop Terminal |
|---|---|---|
| Present Worth Costs | 13.1 | 23.1 |
| Project Costs | 12.3 | 25.0 |
| Annual Operation and Maintenance Costs | 0.5 | 0.5 |

TABLE 4.2.1-5

GRIT AND SCREENING QUANTITIES

| HEADWORKS FACILITY | YEAR 2020 ANNUAL AVERAGE FLOW (mgd) | 1973 TO 1983 ANNUAL AVERAGE SCREENING REMOVAL RATE ($ft^3$/mil gal)(1) | ESTIMATED ANNUAL AVG SCREENING REMOVAL RATE ($ft^3$/mil gal)(2) | AVERAGE SCREENING VOLUME ($yd^3$/day) | MAXIMUM SCREENING VOLUME ($yd^3$/day) | 1973 TO 1983 ANNUAL AVERAGE GRIT REMOVAL RATE ($ft^3$/mil gal)(1) | ESTIMATED ANNUAL AVERAGE GRIT REMOVAL RATE ($ft^3$/mil gal)(2) | AVERAGE GRIT VOLUME ($yd^3$/day) | MAXIMUM GRIT VOLUME ($yd^3$/day) |
|---|---|---|---|---|---|---|---|---|---|
| **NORTH SYSTEM** | | | | | | | | | |
| Chelsea Creek | 141 | 0.8 | 1.2 | 4 to 6 | 13 to 19 | 0.4 | 0.6 | 2 to 3 | 6 to 9 |
| Columbus Park | 58 | 0.6 | 0.9 | 2 to 3 | 5 to 8 | 0.3 | 0.5 | 0.5 to 1 | 2 to 3 |
| Ward Street | 94 | 1.0 | 1.5 | 4 to 5 | 11 to 16 | 0.4 | 0.6 | 1.5 to 2 | 4 to 6 |
| Winthrop Terminal(3) | 27 | 1.8 | 1.5 | 1.5 | 5 | - | - | - | - |
| Deer Island | 320 | - | - | - | - | - | 3.0 | 30 to 32 | 89 to 95 |
| TOTAL | 320 | - | - | 11.5 TO 15.5 | 34 TO 48 | - | - | 36 | 107 |
| **SOUTH SYSTEM** | | | | | | | | | |
| Nut Island | 150 | - | 2.0 | 11 | 33 | -- | 2.0 | 11 | 33 |

(1) Reported in "Deer Island Facilities Plan Volume I Fast-Track Improvements" by Havens and Emerson/Parsons Brinckerhof (1983)

(2) Estimated removal rate after the fast-track improvements are complete.

(3) Winthrop Terminal removal rates were lowered to account for the elimination of the primary clarifier dewatering operation once the new facilities are operational.

is required at Deer Island to protect the new mechanical equipment and to reduce quantities of grit that can accumulate in treatment plant conduits, channels, and basins.

Deer Island Grit Facility

Additional grit removal facilities will be provided on Deer Island, upstream of the primary clarifiers. In addition to the flow from the North Main Pumping Station, the facility would also receive flow from the Winthrop Terminal Headworks. The facility would be sized to handle 913 mgd. Aerated and centrifugal grit chambers were evaluated in detail for use on Deer Island.

Aerated Grit Chamber - The aerated grit removal system would consist of twelve tanks. The system was designed so that any ten of the twelve tanks will handle the peak flow in the year 2020. The two remaining tanks will be held in reserve. The aerated grit chambers were sized for a minimum 3-minute detention time.

Centrifugal Grit - The centrifugal grit removal system consists of two batteries of eight tanks. Two of the 16 tanks are held in reserve.

The sizing criteria and equipment required for the aerated and centrifugal grit removal system are presented in Table 10.2.1-6.

Grit and Screenings Quantities

Anticipated grit and screenings quantities for the North System preliminary treatment facilities are presented in Table 10.2.1-5. The screenings removal rates for the improved remote headworks facilities are within the same range as the rates for other New England plants and large plants throughout the country. As previously discussed, the grit chambers of the remote headworks will be supplemented by facilities on Deer Island. An average annual grit removal rate of 3.0 $ft^3$/mg was used as the total removal rate of the North System headworks facilities. This removal rate is appropriate for the combined sewer systems like the North System, based on the removal rates for other systems. The total average annual volume of screenings is 11.5 to 15.5 $yd^3$ per day. Up to 48 $yd^3$ per day may have to be handled on a peak day. The total average annual grit quantities would be 36 $yd^3$ per day. A total volume of up to 107 $yd^3$ may have to be handled on a peak day.

Air Emissions - The Deer Island grit chambers will be covered to provide a means to collect the discharge of volatile organic compounds (VOCs) and odors. The air above the water surface of the grit chambers and in the grit handling area would be treated through a two-stage system, of a wet scrubber with packed tower followed by an activated carbon filter. The system will treat 12 air changes per hour. The air emissions control facilities for the aerated system would be larger and more costly than the facility required for the centrifugal system because of the larger air volume in the grit building. A more detailed description of air emission control is

## TABLE 10.2.1-6
## DEER ISLAND GRIT REMOVAL SIZING CRITERIA

### AERATED GRIT CHAMBERS

Grit Tanks

| | |
|---|---|
| Number (Includes two standby tanks) | 12 |
| Size | |
| length | 77 ft |
| width | 23 ft |
| depth | 15 ft |
| Capacity | 92 mgd |
| Detention time at peak flow | 3 min. |
| Air Supply | 8 to 14 cfm per linear ft |
| Capture Efficiency | 95% of material > 0.3 mm Sp Gr diameter = 2.65 |

Grit Slurry Pumps

| | |
|---|---|
| Number (Includes 50 percent redundancy) | 24 |
| Capacity | 150 to 200 gpm at 30 ft tdh |
| Horsepower | 5 hp |

### CENTRIFUGAL GRIT CHAMBERS

Grit Tanks

| | |
|---|---|
| Number (Includes two standby tanks) | 16 |
| Size | 24 ft diameter |
| Capacity | 70 mgd |

Grit Slurry Pumps

| | |
|---|---|
| Number (Includes 50 percent redundancy | 32 |
| Capacity | 150-200 gpm, 30 ft tdh |
| Horsepower | 5 hp |

contained in Section 10.6.

The fast-track improvements to the remote headworks include odor control scrubber systems for each of the headworks. Control of VOC air emissions is not provided at the headworks facilities as part of the fast-track improvements. However, once the odor control facilities are operating, testing for VOC air emissions will be conducted according to DEQE protocol.

Cost - Preliminary capital and operation and maintenance costs of the aerated and the centrifugal grit removal alternatives include combining the Winthrop Terminal flow with the Deer Island Grit Facility. The capital costs have been divided into equipment, structures and engineering. The operation and maintenance costs for the aerated and centrifugal grit removal alternatives have been divided into salaries and wages, power costs, and equipment maintenance. Table 10.2.1-7 summarizes capital and operating costs for the two grit removal alternatives.

## 10.2.2 EVALUATION OF ALTERNATIVES

The following is an evaluation of the screening and grit alternatives for the Nut Island Headworks and the grit removal alternatives for Deer Island. The screening alternatives retained for detailed analysis are climber and catenary mechanical screens. The grit removal alternatives are aerated and centrifugal grit chambers.

### Screening Alternatives at Nut Island

Evaluation of the screening alternatives indicate that the climber and catenary screens would provide levels of treatment that are essentially equal. However, there are several notable differences. The staff and equipment maintenance requirements of the catenary screens are greater than for the climber screens. Also, the climber screens are rated slightly more reliable by the Operations Review Committee.

A summary of the evaluation of the screening alternatives is presented in Table 10.2.2-1.

### Grit Removal Alternatives at Nut Island and Deer Island

An explanation of the rating for each evaluation criterion for grit removal alternatives at Nut and Deer Island follows:

Air Emissions

The air emissions from either of the grit removal alternatives at both Nut Island and Deer Island are small when compared to the emissions from the downstream unit processes. Air emissions and odor control facilities for the aerated grit alternative at Nut Island would have to treat approximately 48,000 scfm of air. The air flow from the centrifugal grit chambers is about 11,000 scfm. At Deer Island, the aerated grit chamber air flow to be treated is approximately 144,000 scfm, while the centrifugal air flow is 29,000 scfm. The air flow

## TABLE 10.2.1-7

## DEER ISLAND GRIT REMOVAL COSTS

### CAPITAL COSTS

| | Aerated | Centrifugal |
|---|---|---|
| Structures | 4,990,000 | 2,930,000 |
| Equipment | $3,950,000 | $2,240,000 |
| Engineering and Contingencies | 3,090,000 | 1,750,000 |
| Totals | $12,030,000 | $6,920,000 |

### ANNUAL OPERATION AND MAINTENANCE COSTS

| | | |
|---|---|---|
| Salaries and Wages | $450,000 | $450,000 |
| Power | 290,000 | 30,000 |
| Equipment Maintenance | 250,000 | 150,000 |
| Totals | $990,000 | $630,000 |

**TABLE 10.2.2-1**
**NUT ISLAND**
**SCREENING UNIT PROCESS**
**EVALUATION OF ALTERNATIVES**

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Climber Screens | Catenary Screens | |
| **ENVIRONMENTAL** | | | |
| Air Emissions | Minimal | Minimal | Air emissions requirements are the same. |
| Noise Control | Minimal | Minimal | Both alternatives are enclosed. |
| Visual Impacts | Modest | Minimal | Climber alternative requires a higher building. |
| Environmental Criteria | Minimal | Minimal | Alternatives do not impact environmental issues. |
| Traffic | 1 trip/day of screenings | 1 trip/day of screenings | Traffic during construction and operation is the same. |
| **TECHNICAL** | | | |
| Area Requirements | 27,000 $ft^2$ | 27,000 $ft^2$ | Screening building areas are the same. |
| Reliability/Flexibility | High | Acceptable | The climber alternative is preferred from an operational and maintenance standpoint. |
| Constructibility | Minimal | Minimal | No unusual construction conditions. |
| Personnel Safety | Normal | Normal | Requirements are common to other screening facilities. |
| Staffing Requirements | 8 persons | 9 persons | Alternatives require the same number of operations personnel, but the catenary unit may require more maintenance personnel. |
| Operational Complexity | Typical | Typical | Highly skilled operators and maintenance staff are not required. |

**TABLE 10.2.2-1**
**NUT ISLAND**
**SCREENING UNIT PROCESS**
**EVALUATION OF ALTERNATIVES**

**(continued)**

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Climber Screens | Catenary Screens | |
| Power Needs | 3 Kw | 3 Kw | Power needs are the same. |
| Chemical Requirements | --- | --- | Chemical requirements are the same. |
| Quantity of Residuals | 12 $yd^3$ | 12 $yd^3$ | Screening removal efficiencies are the same. |
| Quality of Residuals | Typical | Typical | Both alternatives treat the same influent. |
| Quantity and Quality of Spoils | 4500 $yd^3$ at site A | 4500 $yd^3$ at site A | Screening building areas are the same. |
| Effluent Quality | --- | --- | Both alternatives provide efficient screening. |
| **INSTITUTIONAL** | | | |
| Timely Implementation | Modest | Modest | Construction is standard for both alternatives. |
| Permitting | Minimal | Minimal | Permitting will not hinder project implementation. |
| External and Internal Coordination | Minimal | Minimal | Existing plant at Nut Island must be kept in operation during construction. |
| Demand For Unique Construction Resources | None | None | No unique resources are required. |
| Flexibility to Meet Future Changes | Good | Good | Both alternatives have adequate future hydraulic and load capacity. |

**TABLE 10.2.2-1**
**NUT ISLAND**
**SCREENING UNIT PROCESS**
**EVALUATION OF ALTERNATIVES**

**(continued)**

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Climber Screens | Catenary Screens | |
| **COSTS** | | | |
| Present Worth Costs | $2.57 million | $2.25 million | Costs do not include common facilities such as screenings building, odor control, etc. |
| Capital Costs | $1.12 million | $0.65 million | |
| Annual Operation and Maintenance Costs | $0.24 million | $ 0.26 million | |

differences are due to the large air volume of the building required for the aerated grit chambers.

Noise Control

At the Nut Island Headworks the sound level for the aerated grit alternative was determined to be less than 10 dBA at the nearest neighbor. No significant noise sources are associated with the centrifugal grit removal alternative. No special noise control is required at Nut Island or Deer Island for either the aerated or centrifugal grit removal alternatives as both units will be enclosed. A minimal level of effort is needed to control noise.

Visual Impacts

New headworks facilities at Nut Island will significantly alter the visual image of the peninsula when viewed from both Hough's Neck and the Quincy Shore. The Quincy shore viewers' perception of the new headworks will not be significantly different for the two alternatives. From the Hough's Neck viewers' perspective, however, a building covering the aerated grit chambers would be more visible than a building housing centrifugal grit chambers would be.

The height of the aerated grit building would be approximately 5 ft above existing grade at site A, which is located where the existing digesters now stand, and 11 ft above existing grade at site D, located between the Main Building and the primary clarifiers. The centrifugal grit structure would be at existing grade for both sites. The relative difference in building heights would result in a modest impact on the view from Hough's Neck. The visual impacts for both grit removal alternatives will be mitigated by construction of earthen berms and by tree plantings.

Environmental Criteria

Relative to their potential impacts on land resources, the two alternative preliminary treatment systems are each judged to have minimal effect when considered from an environmental standpoint. The reasons for this determination are given below:

- Neither alternative displaces nor will have a direct effect on historic or archaeological resources;
- Neither alternative will affect floodplain or wetlands;
- Neither alternative will affect wildlife or endangered species;
- Neither alternative requires significant land area which would decrease the overall potential for developing recreational opportunities.

Traffic

During construction, truck and barging trips for personnel, materials, and equipment will be the same for both of the grit removal alternatives. At Nut Island. one truck trip per day will be necessary to transport grit off-site for both alternatives. At Deer Island each alternative may require an average of 2 to 3 truck trips per day. Trucks will be barged on and off Deer Island.

Area Requirements

At the Nut Island headworks facility the overall area requirements of the grit chambers is approximately 13,000 $ft^2$ for the four aerated grit chambers and 12,500 $ft^2$ for the six centrifugal grit chambers. When combining the grit chamber structure with the screening building, the headworks facilities area is approximately 40,000 $ft^2$ for both alternatives.

At Deer Island the twelve aerated grit chambers and grit handling and operations facilities will cover approximately 41,000 $ft^2$. The centrifugal grit removal alternative would cover approximately 50,000 $ft^2$.

Reliability/Flexibility

The aerated and centrifugal grit removal alternatives for Nut and Deer Islands have tankage and equipment redundancy that allows for long-term maintenance and standby capability while providing for the necessary treatment over the anticipated flow range. The aerated grit chambers are more mechanized because of the blowers needed to supply air to the wastewater, and the screw conveyers used to collect and remove settled grit from the chambers. The added mechanization increases the risk of operational problems. If the blowers are inoperable, then a fraction of the grit entering the tanks will settle to the bottom of the tank along with a portion of the organic material in the wastewater. If screw conveyers are inoperable, then grit cannot be removed from the tank and the tank must be drained and taken out of service. The centrifugal grit chambers use a paddle to help maintain a constant flow velocity. Failure of the paddle motors will only impact the quality of the grit residual during low flow. Without the paddle, the efficiency of grit removal will be high, operating over the expected flow range. However, at low flows the organic material present in the wastewater may also settle.

Both the aerated and centrifugal systems pump grit to concentrating and washing equipment. The equipment, common to both alternatives, is provided with a standby capability. Two pumps are provided for each of the aerated grit chambers and each of the centrifugal grit chambers.

Operating properly, both systems will effectively remove grit and keep organic material in suspension over the entire range of anticipated flows and loads. The aerated system has a long history of use at major wastewater treatment facilities. Centrifugal systems have been successfully implemented at many treatment facilities in the United States since the

mid-1970s; however, these systems do not have long-term operating history at treatment plants of over 100 mgd average daily flow. Centrifugal grit chambers of the size evaluated for this project have been operating in Milwaukee, WI since late 1986.

The aerated grit chamber is considered acceptable from a reliability/flexibility standpoint due to the mechanization involved. Centrifugal grit chambers are ranked at a high level.

Constructibility

Construction of the aerated or centrifugal grit chambers at Nut or Deer Island presents no special difficulties with regard to construction technique, duration or scheduling. Both alternatives present "minimal" conditions for construction.

Personnel Safety

Each of the grit removal alternatives are enclosed to allow for control of odors and air emissions. Enclosing the grit chambers creates an environment for workers requiring ventilation for normal maintenance and other safety measures suitable for enclosed areas. Headworks facilities that are enclosed and require these safety measures are not unusual. Safety levels for both of the grit removal alternatives are normal.

Staff Requirements

Manpower needs for operation and maintenance would be the same for both grit removal alternatives. Operation of the grit facilities for 24 hours per day, 7 days a week requires eight operations personnel. For the aerated grit removal alternatives,,a maintenance staff of three persons is required for 8 hours on 3 days per week. The centrifugal grit removal alternative requires two persons on the same maintenance schedule.

Operation of the Deer Island grit facilities requires 12 operators and 3 maintenance staff personnel. The facilities must be manned by the operations staff 24 hours per day, 7 days a week. Maintenance personnel work on 8 hour shifts, five days a week.

Operational Complexity

Operation of both the aerated and centrifugal grit chambers alternatives is not difficult. For both alternatives there are no adjustments to process control for varying flows. Maintaining the equipment for the aerated system may be more time consuming than for the centrifugal system because of the additional equipment employed. The level of operational complexity for both alternatives is typical.

Power Needs

Grit removal at Nut Island would require an average of 140 kw for the aerated grit chambers and 20 kw for the centrifugal grit chambers. The need to provide air to the aerated chambers

constitutes the primary difference in power needs. Power associated with pumping grit is the same for both alternatives. At Deer Island the aerated grit chambers would require 600 kw, and the centrifugal chambers would require 60 kw.

Chemical Requirements for Operation

Odor and emissions control is the only process at the Nut Island headworks and the Deer Island grit facility that requires significant quantities of chemicals. The ventilation air flow for each alternative must be treated with chemicals in packed towers, and by activated carbon columns.

Significantly more chemicals are needed at both locations for the aerated grit chamber alternative because greater air flows need to be treated from the much larger structure required to cover the aerated chambers.

Quantity of Residuals Generated

Grit removal efficiencies for the two alternative processes are assumed to be the same. On an average day at the Nut Island facility, 19 $yd^3$ of grit would have to be handled. The capability of handling up to 57 $yd^3$ per is provided. At the Deer Island facility 68 $yd^3$ would have to be handled on an average day and 204 $yd^3$ on the maximum day.

Quality of Residuals Generated

The quality of the residuals generated for both alternatives is typical. Both alternatives provide effective means for removing grit particles while keeping organic material suspended for removal by downstream treatment processes. Grit removal from either the aerated or centrifugal grit chambers is concentrated and washed before transporting for disposal.

Quantity and Quality of Spoils for Disposal and Relocation

The excavation of material required for each of the grit chamber alternatives at Nut Island is approximately the same. Construction of aerated grit chambers would generate 12,000 $yd^3$ of excavated material, while construction of centrifugal chambers would generate approximately 11,000 $yd^3$. At Deer Island the construction of aerated grit facilities would generate approximately 37,000 $yd^3$ of spoils, while construction of the centrifugal chambers would generate approximately 30,000 $yd^3$.

Ability to Provide Desired Effluent Quality

The grit removal process removes sand, gravel, other minute mineral matter, and non-putrescible organics. Removal of these materials protects moving mechanical equipment from abrasion and abnormal wear, and reduces the quantity of grit that accumulates in conduits and channels. Both grit removal alternatives will meet the required grit removal criteria.

Timely Implementation

The relative difficulty expected in maintaining the installation schedule for the aerated and centrifugal grit chamber alternatives at both the Nut Island and Deer Island plants is rated as modest.

From a technological standpoint, the alternatives are considered simple and consist generally of standard-size mechanical and electrical equipment -- chains, electric motors, pumps, compressors and limited instrumentation for gauging flow rates and starting and stopping the equipment. Construction will require standard concrete work and standard installation of mechanical equipment.

Facilities for odor control at Nut and Deer Islands will also consist of relatively standard devices in standard unit sizes.

Permitting

Both of the options being considered for preliminary treatment are rated as having a minimal effect on permitting of the facility. Neither option is expected to have a major effect on the ability of the facility to meet any of its air or water quality permit requirements. Further, individual environmental permits should not be required to use any of the unit processes or equipment involved.

External and Internal Coordination Requirements

The extent to which each of the proposed options will pose significant coordination requirements is considered to be extensive, primarily with respect to the internal coordination requirements for the work to be done at the Nut Island site.

Placement of the new preliminary treatment facility at this site, regardless of the grit removal options chosen, will require extremely close coordination between engineers, contractors, vendor/suppliers, and the existing facility staff.

The proposed facility improvements will have to be located on sites already occupied by the existing primary treatment works which themselves must be kept operational until the new primary treatment system at Deer Island is ready. Consequently, considerable time and attention will have to be given to the timing and sequencing of the construction of the preliminary treatment units. Design and construction work will also have to take into consideration the need to work around most of these existing structures, in order to ensure that these requirements are met.

At Deer Island the extent to which each of the proposed options will pose significant coordination requirements is considered to be minimal, primarily with respect to the coordination requirements of the other treatment facilities on Deer Island.

Demand for Scarce or Unique Construction Resources

With respect to the ''scarcity'' parameter, these components of the overall project are rated as difficult. The demand for construction labor of the type that will be required for these units by the third harbor tunnel and Central Artery construction projects can be expected to impose some constraints on this effort. There are virtually no unique components involved in any of the contemplated preliminary treatment options.

Flexibility to Meet Future Changes

The flexibility to meet future changes, particularly with respect to the influent flows and loads, are limited primarily by the hydraulic capacity of the grit chambers. Accordingly, this characteristic is rated as good for both alternatives.

Costs

For Nut Island the centrifugal grit chamber alternative is much more cost effective at $3.84 million than the aerated grit chamber alternative at $5.54 million. Implementation of the centrifugal system on Deer Island would also be more cost effective. The centrifugal grit chamber present worth cost is $9.86 million while the aerated grit chamber cost is $16.44 million.

At both the Nut and Deer Island facilities, the centrifugal grit removal alternative becomes even more cost effective with an increase in power costs, since the aerated grit removal alternative is much more power intensive.

Evaluation Matrix

Table 10.2.2-2 summarizes the evaluation of grit removal alternatives.

## 10.2.3 SELECTION OF RECOMMENDED PRELIMINARY TREATMENT FACILITIES

New preliminary treatment facilities are required at Nut Island and Deer Island. Existing preliminary treatment facilities at the remote headworks of Ward Street, Columbus Park and Chelsea Creek will be retained. At Nut Island, considerations were given to screening alternatives and grit removal alternatives. Climber and catenary screens have 3/4-inch bar spacing. Both types have nearly identical environmental impacts, institutional impacts and technical requirements. However, the climber screen is rated slightly higher from an operational and maintenance standpoint.

Climber screens were recently selected by the Authority for replacement of existing screens at remote headworks facilities. Authority personnel will be familiar with their operation and maintenance by the time the Nut Island Headworks are on-line. Based on this operator familiarity and an operation and maintenance preference, the climber screens are selected over

TABLE 10.2.2-2

NUT ISLAND AND DEER ISLAND
GRIT REMOVAL UNIT PROCESS
EVALUATION OF ALTERNATIVES

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Aerated Grit Chambers | Centrifugal Grit Chambers | |
| **ENVIRONMENTAL** | | | |
| Air Emissions | | | Air emissions are approximately the same. Larger air treatment system for aerated alterantive. |
| Nut Island | 48,000 | 11,000 | |
| Deer Island | 144,000 | 29,000 | |
| Noise Control | Minimal | Minimal | Both alternatives are enclosed. |
| Visual Impacts | Modest | Minimal | At Nut and Deer Island the aerated grit building is higher. |
| Environmental Criteria | Minimal | Minimal | Alternatives do not impact environmental issues. |
| Traffic (for grit removal) | | | |
| Nut Island | 1 trip/day | 1 trip/day | Traffic during construction and operation is the same. |
| Deer Island | 2-3 trips/day | 2-3 trips/day | |

TABLE 10.2.2-2

NUT AND DEER ISLAND
GRIT REMOVAL UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Aerated Grit Chambers | Centrifugal Grit Chambers | |
| **TECHNICAL** | | | |
| Area Requirements | | | |
| Nut Island | 13,000 $ft^2$ | 12,500 $ft^2$ | Area requirements are nearly identical. |
| Deer Island | 40,000 $ft^2$ | 40,000 $ft^2$ | |
| Reliability/Flexibility | Acceptable | High | Both alternatives operate effectively over the flow range. Aerated is more mechanical. |
| Constructibility | Minimal | Minimal | No unusual construction conditions. |
| Personnel Safety | Normal | Normal | Requirements are common to other screening facilities. |
| Staffing Requirements | | | |
| Nut Island | 11 persons | 10 persons | Alternatives require the same number of people. |
| Deer Island | 15 persons | 15 persons | |
| Operational Complexity | Typical | Typical | Highly skilled operators and maintenance staff are not required. |

TABLE 10.2.2-2

NUT ISLAND AND DEER ISLAND
GRIT REMOVAL UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Aerated Grit Chambers | Centrifugal Grit Chambers | |
| Power Needs | | | |
| Nut Island | 140 Kw | 20 Kw | Aerated alterantive requires more power because of air compressors. |
| Deer Island | 600 Kw | 60 Kw | |
| Chemical Requirements | --- | --- | Aerated alternative requires more power because of air compressors. |
| Quantity of Residuals | | | |
| Nut Island | 12 $yd^3$ | 12 $yd^3$ | Grit removal efficiencies are the same. |
| Deer Island | 32 $yd^3$ | 32 $yd^3$ | |
| Quality of Residuals | Typical | Typical | Both alternatives treat the same influent. |
| Quantity and Quality of Spoils | | | |
| Nut Island | 12,000 $yd^3$ at site A | 11,000 $yd^3$ at site A | The facility areas are the same. |
| Deer Island | 37,000 $yd^3$ | 30,000 $yd^3$ | |

TABLE 10.2.2-2

NUT ISLAND AND DEER ISLAND
GRIT REMOVAL UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Aerated Grit Chambers | Centrifugal Grit Chambers | |
| Effluent Quality | Same | Same | Both alterantives meet the required removal criteria. |
| **INSTITUTIONAL** | | | |
| Timely Implementation | Modest | Modest | Construction is standard for both alternatives. |
| Permitting | Minimal | Minimal | Permitting will not hinder project implementation. |
| External and Internal Coordination | | | |
| Nut Island | Extensive | Extensive | Existing plant at Nut Island must be kept in operation during construction. |
| Deer Island | Minimal | Minimal | Coordination of Deer Island Grit Facilities is minimal. |
| Demand For Unique Construction Resources | N/A | N/A | Other large projects in Boston will compete for labor. |

TABLE 10.2.2-2

NUT ISLAND AND DEER ISLAND
GRIT REMOVAL UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| CRITERIA | EVALUATION | | COMMENTS |
|---|---|---|---|
| | Aerated Grit Chambers | Centrifugal Grit Chambers | |
| Flexibility to Meet Future Changes | Good | Good | Both alternatives have adequate future hydraulic and load capacity. |
| **COSTS** | | | |
| Nut Island | | | |
| Present Worth Costs | $5.86 million | $4.09 million | At Nut Island costs favor centrifugal grit chambers. |
| Capital Costs | $3.95 million | $2.40 million | |
| Annual Operation and Maintenance Costs | $0.41 million | $0.33 million | |
| Deer Island | | | |
| Present Worth Costs | $16.44 million | $9.86 million | At Deer Island costs favor centrifugal grit chambers. |
| Capital Costs | $12.07 million | $6.98 million | |
| Annual Operation and Maintenance Costs | $0.99 million | $0.63 million | |

the catenary screens.

For grit removal, aerated grit chambers and centrifugal grit chambers were evaluated. Aerated grit chambers have been used for many years at major municipal wastewater treatment facilities and are effective in removing grit. Centrifugal units are more recent in their development and have been installed in large plants within the last few years. Both methods of grit removal are fully proven. The environmental and institutional impacts of the grit removal alternatives are nearly identical, although the volume of air requiring emission control is less in the case of centrifugal units. Costs favor centrifugal units. Capital costs for the centrifugal system are 60 percent of the aerated grit units' capital costs, and operation and maintenance costs for centrifugal units are 80 percent of the O & M costs for the aerated grit units. Because both units are proven for municipal grit removal, and the costs favor centrifugal units, centrifugal units are selected for the Nut Island Headworks.

For the new Deer Island grit removal facility, alternatives considered were aerated or centrifugal grit removal. For the same reasons outlined above for Nut Island -- especially costs -- centrifugal grit removal facilities are recommended.

Preliminary treatment options were evaluated for the Winthrop Terminal facility. The alternatives were (1) to retain the existing screening facilities and relocate grit removal facilities to the new Deer Island Grit Facility or (2) to abandon the existing screening and grit removal facilities and construct new pumping and screening facilities with grit removal at the Deer Island Grit Facility. Since capital costs for constructing all new facilities were ten times the costs of retaining the existing screening facilities, the option of retaining existing facilities is recommended.

## 10.3 PRIMARY TREATMENT

### 10.3.1 PRIMARY SEDIMENTATION

Primary sedimentation reduces the suspended solids and the associated biochemical oxygen demand (BOD) in wastewater by removing settleable solids. Primary sedimentation typically removes 30 to 60 percent of the suspended solids and 15 to 35 percent of the BOD.

The primary sedimentation alternatives that were recommended for detailed evaluation in the Section 8.0 were conventional (unstacked) rectangular clarifiers and stacked rectangular clarifiers. These alternatives were selected for detailed evaluation primarily because of their efficient land use (the four batteries of conventional primary clarifiers would cover approximately 30 acres while the stacked rectangular clarifiers would cover approximately 20 acres), and their treatment reliability.

As shown in Section 9.0, preliminary layouts of the complete planned treatment plant on the Deer Island site indicated that a plant which included conventional units would require the entire site just for tankage and would not allow space for visual buffering berms, plant roadways, control buildings, and other ancillary facilities. For this reason, conventional

rectangular clarifiers were not considered as a viable primary sedimentation alternative. Therefore, the use of stacked rectangular clarifiers is the only alternative considered and the recommended plan presented in Section 11.0 is based on stacked units.

## 10.4 SECONDARY TREATMENT

The following section describes the three secondary treatment alternatives retained for detailed evaluation; evaluates each system with respect to the evaluation criteria presented in Section 4.0; and concludes with the selection of the recommended plan.

### 10.4.1 DESCRIPTION OF ALTERNATIVES

Secondary treatment removes the BOD and total suspended solids (TSS) remaining in the waste stream subsequent to primary treatment. This section evaluates the three types of secondary biological treatment processes retained for detailed evaluation.

As discussed in Section 8.5, twelve secondary treatment unit processes were evaluated in the preliminary screening of unit processes. Based on area requirements, system performance, and system operational history, three of these processes were retained for detailed evaluation, and are listed below:

- o Air Activated Sludge
- o Oxygen Activated Sludge, and
- o Coupled System (packed tower and activated sludge)

Each process has been sized for this evaluation based on the preliminary design year flows and loadings to the secondary treatment process as given in Table 10.4.1-1. The BOD and TSS loading to the secondary process is based on the expected removal efficiency of the primary treatment process discussed in Section 7.1. An allowance equivalent to ten percent of the average day loading of BOD and TSS has been added to the raw wastewater load to account for the recycle from solids processing (sidestream). Under maximum-day and maximum-day-with-storm conditions, ten percent of the maximum three day loading was added to the raw wastewater load to account for sidestreams. This assumption has been coordinated with the Residual Management Facilities Plan (RMFP) efforts. However, by agreement with the RMFP consultant, if a specific residuals handling process produces a significantly greater strength sidestream, the sidestream would be treated separately to reduce it to the ten percent level used in this facilities plan, prior to its return to the wastewater treatment plant.

Each system has been designed to produce an annual average effluent quality of 15 mg/l of BOD and TSS; 30 mg/l of BOD and TSS for the maximum thirty day period; and 40 mg/l of BOD and TSS on the maximum day.

The sizing criteria used in the preliminary design of the three alternatives are presented in Table 10.4.1-2. These criteria were developed in conjunction with the MWRA staff and review consultants and are based on existing design standards and current engineering practice.

## TABLE 10.4.1-1

## PRELIMINARY
## DESIGN YEAR FLOWS AND LOADINGS
## TO SECONDARY TREATMENT

| | Low Groundwater | | | High Groundwater | | |
|---|---|---|---|---|---|---|
| | Avg. Day | Max. Day | Max. Day With Storm | Avg. Day | Max. Day | Max. Day With Storm |
| Flow (mgd) | 374 | 511 | 1065 | 714 | 966 | 1074 |
| TSS | | | | | | |
| (1000 lb/day) | 237 | 481 | 896 | 268 | 643 | 861 |
| (mg/1) | 76 | | | 45 | | |
| BOD | | | | | | |
| (1000 lb/day) | 411 | 823 | 1042 | 439 | 906 | 983 |
| (mg/1) | 132 | | | 74 | | |

Note: The above average day BOD and TSS loadings include a ten percent of average day loadings allowance for the solids processing sidestream. The maximum day and maximum day with storm loadings include a ten percent of the three day maximum loading allowance to account for this sidestream.

## TABLE 10.4.1-2

## SECONDARY TREATMENT SIZING CRITERIA

| | Air Activated Sludge | Oxygen Activated Sludge | Coupled System |
|---|---|---|---|
| **BIOFILTERS** | | | |
| Type | --- | --- | plastic media |
| Organic Loading, ave. (lb $BOD_5$ / 1000 $ft^3$) | --- | --- | 80-100 |
| Hydraulic Loading, peak $gpm/ft^2$ | --- | --- | 2.9 |
| **AERATION BASIN** | | | |
| Hydraulic Residence Time (hr) | 1.85 | 1.1 | 1.25 |
| F/M Ratio ($day^{-1}$) | 0.55 | 0.72 | 0.55 |
| SRT (day) | 3.2 | 2.3 | 3.2 |
| MLSS (mg/l) | 2000 | 2500 | 2000 |
| Volatile Solids (%) | 80 | 80 | 80 |
| Effluent Soluble BOD (mg/l) | 6 | 6 | 6 |
| lb Oxygen Required per lb BOD Removed | 0.82 | 0.75 | 0.82 |
| Alpha | 0.45 | --- | 0.45 |
| Beta | 0.98 | --- | 0.98 |
| Minimum Dissolved Oxygen Concentration (mg/l) | 2.0 | 2.0 | 2.0 |
| Mixing Requirements $scfm/ft^2$ | 0.12 | --- | 0.12 |
| $hp/1000\ ft^3$ | --- | 2.0 | --- |
| Oxygen Generation Type | --- | Cryogenic | --- |
| **SECONDARY CLARIFIERS** | | | |
| Type | Rectangular | Rectangular | Rectangular |
| Ave Overflow Rate, ($gpd/ft^2$) | 700 | 620 | 700 |
| Max Solids Loading, ($lb/day/ft^2$) | 29 | 32 | 30 |
| Recycle Rate (%) | 10-75 | 10-75 | 10-75 |

Activated Sludge

The activated sludge process is a proven, widely used municipal wastewater treatment system. The process consists of two intra-dependent operations: aeration and clarification. In aeration, organic matter in the primary effluent is converted by the mixed liquor microorganisms into water, carbon dioxide, and new microorganisms. During aeration, colloidal and soluble organic matter that cannot be separated from the wastewater by sedimentation is converted into suspended matter (microorganisms), which can be separated by sedimentation. Following aeration, the suspended solids or microorganisms are separated from the liquid in the secondary clarifiers. The separated solids are removed from the clarifiers as activated sludge, and recycled to the aeration tanks to maintain a viable microbial population under aeration. The overflow from the secondary clarifiers, secondary effluent, is discharged to the plant outfall following disinfection. New solids, or microorganisms, are constantly being produced during the biological degradation of organic matter. Solids in excess of those required for treatment of the wastewater are removed from the activated sludge system as waste activated sludge. Management of the waste activated sludge, along with the other residuals generated during the treatment of wastewaters, is being planned in the Residuals Management Facilities Plan. The aerobic environment is maintained in the aeration basins through the addition of air or pure oxygen.

Air Activated Sludge

Sizing of the aeration tanks for the air activated sludge system was based on the application of sizing criteria to the preliminary flow and loads expected at high groundwater average day flow conditions. Aeration equipment and blowers were sized to meet the oxygen demand at the peak loading condition. Table 10.4.1-3 presents the preliminary sizing of the air activated sludge system.

A total aeration basin volume of 55 million gallons is required for the indicated SRT and MLSS levels. The secondary system will be divided into four separate batteries. Each battery could be constructed as nine single-pass aeration basins, each 227 ft long by 50 ft wide. The tank basin area is based on an 18 ft sidewater depth. A cost versus depth-of-basin analysis indicated that life cycle costs for aeration basins were essentially equal for depths of 15 to 30 ft. The 18 ft depth was used for this analysis to ensure that adequate area would be provided in the site layouts.

The basins will be constructed with decks to control the discharge of aerosols and volatile organic compounds. All emissions will be subjected to treatment prior to discharge to the atmosphere.

The aerobic environment can be maintained in the air activated sludge system with mechanical surface aerators, or fine or coarse bubble diffused aeration. Cost comparisons conducted during the screening analysis indicated a significant life-cycle cost benefit for fine bubble diffusers. For the purpose of this cost comparison, a fixed grid system of ceramic disc fine

## TABLE 10.4.1-3

## PRELIMINARY DESIGN OF AIR ACTIVATED SLUDGE TREATMENT FACILITY

| | |
|---|---|
| **TANKAGE** | |
| Total Volume (MG) | 55.0 |
| Number of Batteries | 4 |
| Number of Tanks per Battery | 9 |
| Total Number of Tanks | 36 |
| Tank Dimensions, (ft) (W x L x D) | 50 by 227 by 18 |
| Tank Surface Area ($ft^2$) | 11,350 |
| Tank Volume ($ft^3$) | 204,300 |
| **AERATION EQUIPMENT** | |
| Type | Fine Bubble Diffused Air |
| Number of Diffusers per Tank | 2,800 |
| Total Number of Diffusers | 100,800 |
| Total Blank Spaces for Additional Diffusers | 15,120 |
| **BLOWERS** | |
| Type | Single Stage Centrifugal Integral Gear |
| Number of Blowers | 11 |
| Design Inlet Capacity (scfm) | 43,430 |
| Motor Horse Power | 2,500 |
| Blower Building Size (ft) | 180 by 150 |

bubble diffusers was used for aeration. Final design should consider advances in diffuser technology and the equipment available at the time.

The number of diffusers required and the blower sizing is dependent on the oxygen transfer efficiency of the diffusers. Oxygen transfer efficiency (OTE), the mass of oxygen transferred divided by the mass rate of oxygen supplied, is dependent on a number of factors. The clean water OTE for an 18-foot sidewater depth tank providing 17-foot diffuser submergence was taken to be 30 percent. The actual operation oxygen transfer efficiency was calculated using the correction factors alpha and beta of 0.45 and 0.98, respectively. These correction factors account for gas transfer rate and the difference in oxygen saturation between mixed liquor and clean water.

Oxygen transfer is also dependent on the difference between the dissolved oxygen saturation concentration and the operating dissolved oxygen concentration. Saturation concentration increases with water depth and decreases with increasing temperature. Therefore, oxygen transfer is greater in deeper tanks and at lower temperatures. To provide a conservative estimate, the operational oxygen saturation concentration was based on 1/4 tank depth and a temperature of 20° C. Using these variables, the operational OTE was calculated to be 10.7%

The oxygen required per pound of BOD removed is inversely proportional to the food to microorganism ratio (F/M). For the selected F/M of 0.55, and for municipal wastewater, approximately 0.82 pounds of oxygen is required per pound of BOD removed. (It has been assumed, however, that oxygen required per pound of BOD removed will not fall below 0.80, even as the F/M increases). The amount of air that must be supplied to provide the required oxygen is based on air having an oxygen content of about 23 percent by weight. Table 10.4.1-4 summarizes the operating conditions and air requirements for the various flow conditions.

Approximately 100,000 nine-inch ceramic disc diffusers are required for this system. The number of diffusers is based on the assumption that each diffuser will supply 1.2 scfm during average loading, and 3.0 scfm at peak loading conditions.

The extremely fine pore openings of the ceramic diffusers require the installation of air filters capable of removing 95 percent of 0.3 micron particles. The air filtration equipment to be supplied to reduce airborne particulates consists of a roll-type prefilter, followed by an electrostatic precipitator with replaceable media. The filtration equipment will have an installed capacity equivalent to the peak air flow plus the required 10 percent redundancy. The potential for periodic fouling of the ceramic diffusers must be accounted for. To remedy this problem, the proposed system would include an anhydrous hydrochloric acid gas cleaning system. Newer diffuser technology available at the time of design might not require this gas cleaning system.

To supply the required air flow, eleven single-stage integral gear blowers will be provided. This includes blowers required for redundancy. Each blower would have a design inlet capacity of approximately 43,500 scfm and would be driven by a 2500 hp motor. The required horse power

## TABLE 10.4.1-4

## AIR ACTIVATED SLUDGE OPERATING SUMMARY

| | Low Groundwater Conditions | | | High Groundwater Conditions | | |
|---|---|---|---|---|---|---|
| | Avg. Day | Max. Day | Max. Day With Storm | Avg. Day | Max. Day | Max. Day With Storm |
| Flow (MGD) | 374 | 511 | 1065 | 714 | 966 | 1074 |
| Hydraulic Residence Time (hrs) | 3.5 | 2.6 | 1.2 | 1.9 | 1.3 | 1.2 |
| BOD to Secondary Treatment (1000 lb/day) | 411 | 823 | 1042 | 439 | 906 | 983 |
| MLSS (mg/l) | 2000 | 2000-3700 | 1500-3700 | 2000 | 2000-3700 | 1500-3700 |
| MLVSS (mg/l) | 1600 | 1600-3000 | 1200-3000 | 1600 | 1600-3000 | 1200-3000 |
| F/M (1/day) | 0.54 | 0.57-1.06 | 0.67-1.66 | 0.55 | 0.61-1.08 | 0.64-1.55 |
| Oxygen Required/BOD Removed (lb/lb) | 0.83 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| Oxygen Required (lb/d) | 326,000 | 637,000 | 745,000 | 332,000 | 670,000 | 695,000 |
| Air Required (scfm) | 122,000 | 238,000 | 279,000 | 124,000 | 250,000 | 260,000 |
| Required BHP | 6200 | 2,000 | 14,000 | 6000 | 12,000 | 12,200 |

for average and peak conditions is 6,100 and 14,000. Inlet guide vanes would be provided for efficient operation at varying airflow rates.

In all cases, the blowers will discharge into a looped manifold that will run through each battery. Branch pipes running along the sidewall of the aeration tanks are fed from the manifold. From the branch pipes, air flows through the fixed headers on which the ceramic diffusers are mounted.

Blowers furnished with intake and exhaust silencers will be housed in a blower building approximately 180 ft by 150 ft. Air filtration equipment and gas cleaning equipment for the ceramic diffusers will also be housed in the blower building.

The capital cost for the air activated sludge system described above, including secondary clarification described in the following section, has been estimated at $390,000,000, including engineering and contingencies.

This cost includes the costs for materials and construction of the aeration basins, secondary clarifiers, and the blower buildings. Aeration basin costs include concrete decks, and influent and effluent channels. Costs for preliminary site preparation are not included. Equipment costs for this system include blowers with motors and silencers, air filtration equipment, fine bubble ceramic diffusers with all piping and gas cleaning systems, sludge collection equipment, WAS and RAS pumping, instrumentation, air emissions control equipment, and all HVAC, plumbing and electrical equipment.

Operation and maintenance cost for the air activated sludge system has been estimated at $5,620,000 per year. This cost includes salaries and wages for operation and maintenance personnel, power costs, chemical costs for the gas cleaning system, and equipment maintenance costs, spare parts, oil, etc.

A breakdown of capital and operation and maintenance costs is presented in Tables 10.4.1-9 and 10.4.1-10, at the end of this section.

Oxygen Activated Sludge

The oxygen activated sludge unit process operates in the same manner as the air activated sludge system. However, it utilizes pure oxygen rather than air as the aerating gas. Oxygen of approximately 95 percent purity is generated on-site, and is introduced to the head space above the wastewater of the covered aeration basins. Mechanical surface aerators combined with draft tubes transfer oxygen into the mixed liquor, and provide adequate mixing to maintain solids in suspension.

The preliminary flows and loadings used to design the system are identical to those used for air activated sludge, as presented in Table 10.4.1-1.

The key advantage of the oxygen activated sludge process is the increased oxygen utilization efficiency offered by the system. The enriched oxygen condition established over the mixed liquor in the gas-tight, covered reactor induces higher utilization efficiency of oxygen in the wastewater. This allows the use of a higher F/M than that used in the air activated sludge process. The combination of these factors at Deer Island results in an aeration tank volume of about 33 million gallons, as compared to the air activated sludge aeration tank volume of 55 million gallons. The higher F/M, however, results in the production of slightly more waste activated sludge than is produced by the air system. Carrying a higher level of MLSS also necessitates larger secondary clarifiers.

The preliminary sizing and operating summary for the oxygen activated sludge system is presented in Tables 10.4.1-5 and 10.4.1-6. For the selected F/M of 0.73, approximately 0.76 pounds of oxygen is required per pound of BOD removed. (It has been assumed for the oxygen system that the pounds of oxygen required will not fall below 0.75, even as the F/M increases). The system consists of four batteries of oxygenation reactors. Each reactor consists of three separate trains with three stages per train. Each stage is approximately 83 ft long, 83 ft wide, and 18 ft deep. As with the air system, the depth can be increased if more detention time is required, without increasing the spacial requirements.

Mechanical aerators in the first stage would be driven by 150 hp motors. The subsequent stages would have 100 hp motors. The tapered power input permits maximum oxygen transfer in the first stage, and minimum shear for settling in the last stage. The amount of oxygen fed to the first stage of each reactor depends upon the pressure of the gas above the liquid. As the oxygen is consumed by the microorganisms, the gas pressure decreases. A differential switch senses the pressure drop and activates a valve to allow more gaseous oxygen into the reactor.

Oxygen for this system will be provided through cryogenic oxygen generation. Cryogenic air separation involves first compressing feed air and removing impurities such as carbon dioxide and water by low temperature condensation. This is done in a reversing heat exchanger or through molecular sieve prepurifiers, which utilize absorption onto a crystalline molecular sieve medium. Utilizing the difference in boiling points of the various components of air (primarily oxygen and nitrogen), the oxygen is separated from the clear cold air by fractional distillation.

Two 300 ton per day (tpd) oxygen generation units would be provided, as well as a 1000-ton liquid oxygen (LOX) storage tank. Only one generation plant is in operation at any one time, while the second is available as backup. The cryogenic oxygen generation system can be turned down to about 50 percent of design production. If oxygen requirements fall below the minimum available production point, the additional gaseous oxygen will be wasted to the atmosphere. At peak demand, when oxygen requirements exceed the available maximum production point, the LOX will be used to supplement the oxygen supply. Using LOX for peak demands is advantageous compared to constructing larger oxygen units, since the smaller cryogenic generator provides increased system efficiency due to better turn-down at the minimum loading conditions. The

## TABLE 10.4.1-5

## PRELIMINARY DESIGN OF OXYGEN ACTIVATED SLUDGE TREATMENT FACILITY

TANKAGE

| | |
|---|---|
| Total Volume (MG) | 33.2 |
| Number of Batteries | 4 |
| Number of Trains per Battery | 3 |
| Number of Stages per Train | 3 |
| Total Number of Stages | 36 |
| Stage Dimensions, ft (W x L x D) | 83 x 83 x 18 |
| Stage Surface Area ($ft^2$) | 6136 |
| Stage Volume ($ft^3$) | 110,440 |
| Freeboard, ft | 5 |

AERATION EQUIPMENT

| | |
|---|---|
| Type | Mechanical Surface Aerators with Draft Tubes or Lower Mixing Impellars |
| Number of Aerators | 36 |
| Aerator HP Stage 1 | 150 |
| Stage 2 | 100 |
| Stage 3 | 100 |

OXYGEN GENERATION

| | |
|---|---|
| Type | Cryogenic |
| Number of Units | 2 |
| Capacity of Each Unit (ton/day) | 300 |
| Liquid Oxygen (LOX) Storage (tons) | 1000 |
| Compressors | 2 @ 3500 hp<br>2 @ 2500 hp |

## TABLE 10.4.1-6

## OXYGEN ACTIVATED SLUDGE OPERATING SUMMARY

| | Low Groundwater Conditions | | | High Groundwater Conditions | | |
|---|---|---|---|---|---|---|
| | Avg. Day | Max. Day | Max. Day With Storm | Avg. Day | Max. Day | Max. Day With Storm |
| Flow (mgd) | 374 | 511 | 1065 | 714 | 966 | 1074 |
| Hydraulic Time (hrs) | 2.13 | 1.56 | 0.75 | 1.12 | 0.82 | 0.74 |
| BOD to Secondary Treatment (1000 lb/day) | 411 | 823 | 1042 | 439 | 906 | 983 |
| MLSS (mg/l) | 2500 | 2500-5600 | 2000-4000 | 2500 | 2150-4300 | 2000-4000 |
| MLVSS (mg/l) | 2000 | 2000-4500 | 1600-3200 | 2000 | 1700-3400 | 1600-3200 |
| F/M (lb BOD/lb MLVSS) | 0.71 | 0.65-1.40 | 1.0-2.05 | 0.73 | 0.85-1.73 | 0.97-1.91 |
| lb Oxygen Required per lb BOD Removed | 0.76 | 0.75 | 0.75 | 0.76 | 0.75 | 0.75 |
| Oxygen Supplied (tpd) | 157 | 323 | 379 | 160 | 341 | 353 |
| Required LOX (tons) | --- | 22 | 79 | --- | 41 | 53 |

liquid oxygen, used to serve peak demand requirements and provide backup in the event that gaseous oxygen supply is interrupted, is withdrawn from the distillation column and transferred to the on-site storage. Approximately 5 to 15 percent of the rated gaseous capacity of the plant can be produced in liquid oxygen per day. Evaporative losses in LOX storage are approximately 0.2 to 0.3 percent of the total LOX storage.

The cryogenic plant requires an annual system overhaul, which can be accomplished by the manufacturer through a service contract. Estimated costs for such a service contract are $60,000/yr. At this time, the second plant would be brought into service. Approximately four days are required to bring the second plant into operation. This time can be reduced to less than one day if the liquid oxygen storage supply is used for start-up. In the event of unscheduled cryogenic down time, the LOX supply will be used until the second unit becomes operational.

The LOX storage provided is sufficient to handle all loading conditions and unexpected cryogenic failures without having to transport liquid oxygen to the site.

The volume of gas exhausted from the reactors requiring treatment is only about 3000 scfm on an average day, and 6000 scfm on peak days.

To prevent the development of hazardous conditions, the pure oxygen systems are equipped with sensors that detect hydrocarbons within the oxygen atmosphere in the aeration basins. Should hydrocarbons be present at a certain level, an alarm would sound and stop the oxygen feed to prevent the development of hazardous conditions. A purge blower would evacuate the air space above the reactor. When the hydrocarbon level decreases, the oxygen feed is resumed. Performance of oxygen activated sludge systems at existing operations indicates that this occurs relatively infrequently.

A compressor building approximately 110 ft by 100 ft is required to house the inlet compressors for the oxygen generators. Housing is also required around the reversing heat exchangers for noise mitigation.

The capital cost for the oxygen activated sludge system, including clarification, has been estimated at $370,400,000, including engineering and contingencies. Costs for the cryogenic oxygen system include the two cryogenic oxygen generation plants with compressors, expansion turbines, control panels, liquid oxygen storage tank, cooling tower, and miscellaneous equipment, together with the dissolution equipment, which includes 36 mounted aerators, 4 purge blowers, control panels, and miscellaneous equipment. Added to this is the cost of the materials and construction of the covered aeration basins, secondary clarifiers including sludge collection, RAS and WAS pumps, air emissions control equipment, instrumentation and all miscellaneous HVAC, plumbing, and electrical equipment.

Operation and maintenance costs for the pure oxygen system are $5,850,000 per year. This cost includes salary and wages for the necessary operation and maintenance personnel, annual

maintenance contract for the cryogenic unit, power costs, and costs for spare parts and general equipment maintenance.

Tables 10.4.1-9 and 10.4.1-10 at the end of this section itemize the capital and operation and maintenance costs for this system.

Selector-Process Modification

The quality of the final effluent from the activated sludge process is dependent upon the separation of solids and liquid in the secondary clarifiers. Poor separation can result in the loss of solids from the system to the final effluent, with resultant high levels of effluent TSS and BOD.

In recent years there have been significant advances in understanding and controlling the bulking of activated sludge. Bulking is commonly caused by an excess of filamentous organisms, which have poor settling characteristics. Filamentous growth is usually found in aeration systems that have uniformly low, soluble levels of carbonaceous BOPD such as those that exist in completely-mixed or step-feed aeration patterns. The filamentous organisms are more effective scavengers of organic material than floc-florming (well settling) bacteria. Growth by the floc-forming bacteria is favored in systems that have an initial high carbonaceous substrate concentration, such as plug-flow reactors.

A technique to control filamentous growth and to promote a good settling activated sludge is to provide a mixing zone for the RAS and the primary effluent prior to aeration. This provides a high growth-rate environment that promotes floc-forming organisms at the expense of filamentous organisms. This technique is also referred to as a "selector," since it affects the selection of non-filamentous, good settling organisms in the activated sludge process. The technique is equally applicable to the air and oxygen alternatives of the activated sludge process.

Three types of selector zones have been successfully applied to wastewater treatment: a high F/M oxic zone, an anoxic zone (oxygen source is nitrate), and an anaerobic zone. The high F/M oxic zone and the anaerobic selector zones are currently protected under patents owned by Air Products and Chemicals, Inc.

The anaerobic selector was selected for evaluation at the Deer Island plant, since this type has proven to be very effective in conjunction with the high rate (low SRT) activated sludge systems proposed for Deer Island. Anaerobic selectors have been shown to produce assured good settleability and effluent stability when used in conjunction with plug flow type aeration systems.

The anaerobic selector zone should provide about 20 minutes of contact time at average flows. Under high groundwater average flow conditions. this would require 98.000 $ft^2$ of basins with an 18 ft depth. (Contact time is based upon plant flow plus RAS flow.)

Incorporation of an anaerobic selector into the flow path would assure a better settling sludge, and allow for reduction in the size of the final clarifiers. Inclusion of an anaerobic selector prior to the aeration basins, and a reduction in the size of the final clarifiers would result in net capital cost savings of about $30,000,000 for both the air and oxygen systems. Operating costs would be unaffected.

The use of the selector modification was evaluated as an optimization to the air and oxygen activated sludge system. The selector will be considered for inclusion as an operational optimization if either the air or oxygen activated sludge system is recommended for Deer Island. However, for comparison purposes within the context of this section, the activated sludge systems were sized and costed without a selector.

Coupled System

The coupled system retained for detailed analysis consists of a packed tower trickling filter followed by an air activated sludge reactor and clarifier in a series arrangement. An oxygen activated sludge reactor can also be used. (Based on the above comparison between air and oxygen activated sludge, the costs for an oxygen system can be considered essentially equal to those presented herein for the air system.)

The trickling filter is an attached growth biological treatment process, which consists of a bed of highly permeable plastic media on which microorganisms grow, and though which wastewater passes. As the wastewater trickles through the media, the attached growth removes the organics in the waste stream. The activated sludge process, which follows the trickling filter, operates as a suspended growth process, described previously. The coupled system provides the energy efficiency of the trickling filter with the effluent quality associated with the bioflocculation of the activated sludge process.

The sizing of the coupled system was based on the preliminary flows and loads in Table 10.4.1-1, and the sizing criteria in Table 10.4.1-2.

Coupled systems can be designed with varying portions of the BOD removal provided by the trickling filters. To determine the optimum coupled system, percent soluble BOD removed in the trickling filter versus wastewater treatment costs was evaluated. This analysis showed that soluble BOD removals of 35 to 40 percent provide the optimum coupled system. In this range the hydraulic loading of the trickling filter would be between 3 to 6 gpm/$ft^2$, which is above the 3.0 to 3.5 gpm/$ft^2$ maximum rate recommended by manufacturers. Based on these maximum rates, the average day high groundwater loadings were limited to 2.3 gpm/$ft^2$. Using this as the governing criteria, the optimum coupled system removes 50 percent soluble BOD in the trickling filter. Sizing the system based on the given criteria results in 16 trickling filters, 140 ft in diameter and 20 ft deep, and 16 aeration basins 71 ft by 245 ft with an 18 ft sidewater depth. These units could also be increased in depth as previously discussed under the section entitled Air Activated Sludge.

As with the other alternatives, these units would be divided into 4 batteries, each battery consisting of 4 trickling filters and 4 aeration basins.

Both the trickling filters and the aeration basins would be constructed with covers to control the discharge of aerosol, odors, and other volatile compounds. Vent air would be treated through a two-stage odor control system consisting of an air scrubber followed by a carbon filter. Vent air from the aeration tanks would be passed up through the packed tower. Exhaust air from the trickling filter would be recycled or sent to air treatment. Exhausted air would be 200,000 scfm for the average flows, and 340,000 scfm at peak flows.

Primary effluent must be pumped to the trickling filters. This pumping station will serve a dual purpose as pumping station and splitter chamber.

Trickling filter effluent is collected in an underdrain system and flows by gravity to the respective aeration battery. The sizing of the aeration tanks for the coupled system is similar to that of the air activated sludge alternate described previously, but smaller, since the BOD loading to aeration has been reduced through the use of the trickling filters.

As with the air activated sludge alternate, aeration costs were based on using a fixed grid system of 9-inch ceramic disc fine bubble diffusers. In this case, approximately 65,500 diffusers are required. The required air flow would be supplied through eleven 27,000 scfm blowers with 1500 hp motors. Ancillary equipment includes the gas cleaning system and the air filtration system which consists of a roll-type prefilter followed by an electrostatic precipitator. A blower building 150 ft by 180 ft is required to house the blowers and ancillary equipment.

Preliminary sizing of the coupled system is given in Table 10.4.1-7, and operation data for this system is presented in Table 10.4.1-8.

The estimated capital cost, including engineering and contingencies, for the coupled system with clarification is $398,400,000. This cost includes materials and construction of the aeration basins, trickling filter towers, secondary clarifiers, blower building, and pump station. Both the trickling filter and aeration tank costs include covers. Equipment costs for this system include all equipment necessary for the aeration step, as described previously, plus influent pumps, filter media, and the underdrain system for the trickling filter. As with the other alternatives, costs for instrumentation, air emissions control equipment, HVAC, plumbing, and electrical equipment have all been included and reflect installed costs.

The operation and maintenance costs include salary and wages for operation and maintenance personnel, power costs, chemical costs, and general equipment maintenance cost. Operation and maintenance has been estimated at $6,040,000 per year.

The breakdown of capital and operation and maintenance costs are presented in Table 10.4.1-9 and 10.4.1-10.

## TABLE 10.4.1-7

## PRELIMINARY DESIGN OF COUPLED SYSTEM TREATMENT FACILITY

| | |
|---|---|
| **BIOFILTERS** | |
| Type | Cross Flow Type with Plastic Media |
| Number of Batteries | 4 |
| Number of Filters per Battery | 4 |
| Total Number of Filters | 16 |
| Filter Diameter (ft) | 140 |
| Filter Depth (ft) | 20 |
| Number of Pumps | 24 |
| Pump Capacity (gpm) | 50,000 |
| **AERATION TANKAGE** | |
| Total Volume (MG) | 37.5 |
| Number of Batteries | 4 |
| Number of Tanks per Battery | 4 |
| Total Number of Tanks | 16 |
| Tank Dimensions, ft (W x L x D) | 71 x 245 x 18 |
| Tank Surface Area ($ft^2$) | 17,395 |
| Tank Volume ($ft^3$) | 313,110 |
| **AERATION EQUIPMENT** | |
| Type | Fine Bubble Diffused Air |
| Number of Diffusers per Tank | 4,095 |
| Total Number of Diffusers | 65,500 |
| Total Blank Spaces for Additional Diffusers | 9,825 |
| **BLOWERS** | |
| Type | Single Stage Centrifugal |
| Number of Blowers | 11 |
| Design Inlet Capacity (scfm) | 27,000 |
| Motor Horse Power | 1,500 |

## TABLE 10.4.1-8

## COUPLED SYSTEM
## OPERATING SUMMARY

| | Low Groundwater Condition | | | High Groundwater Condition | | |
|---|---|---|---|---|---|---|
| | Average Day | Maximum Day | Maximum Day with Storm | Average Day | Maximum Day | Maximum Day with Storm |
| Flow (mgd) | 374 | 511 | 1065 | 714 | 966 | 1074 |
| TRICKLING FILTER | | | | | | |
| Soluble Influent BOD (mg/l) | 66 | 99 | 61 | 37 | 58 | 57 |
| Soluble Effluent BOD (mg/l) | 18 | 32 | 28 | 19 | 32 | 32 |
| Hydraulic Loading ($gpm/ft^2$) | 1.12 | 1.49 | 3.14 | 2.31 | 2.89 | 3.07 |
| Organic Loading (lb BOD/1000 $ft^3$/day) | 89 | 178 | 216 | 102 | 201 | 210 |
| AERATION | | | | | | |
| BOD to Secondary Treatment (1000 lbs/day) | 247 | 517 | 716 | 302 | 650 | 708 |
| Soluble Effluent BOD (mg/l) | 5 | 9 | 34 | 5 | 11 | 33 |
| Hydraulic Residence (hr) | 2.3 | 1.74 | .83 | 1.25 | .92 | .83 |
| Organic Loading (lb BOD/1000 $ft^3$/day) | 49 | 104 | 144 | 65 | 130 | 142 |

TABLE 10.4.1-9

SECONDARY TREATMENT
CAPITAL COST COMPARISON

| | Air Activated Sludge | Oxygen Activated Sludge | Coupled System |
|---|---|---|---|
| Aeration Basins | | | |
| Structures | $44,100,000 | $25,200,000 | $30,000,000 |
| Equipment | 21,500,000 | 12,300,000 | 14,300,000 |
| Blower Building | | | |
| Structures | 2,800,000 | --- | 2,800,000 |
| Equipment | 10,000,000 | --- | 8,600,000 |
| Oxygen Generation | | | |
| Structures | --- | 2,500,000 | --- |
| Equipment | --- | 21,800,000 | --- |
| Trickling Filter | | | |
| Structures | --- | --- | 13,900,000 |
| Equipment | --- | --- | 17,500,000 |
| Secondary Clarifiers (including sludge pumping station) | | | |
| Structures | 124,900,000 | 135,400,000 | 124,900,000 |
| Equipment | 67,800,000 | 72,000,000 | 67,800,000 |
| Air Emission Control | 9,500,000 | 500,000 | 9,500,000 |
| Subtotal | $288,900,000 | $274,400,000 | $295,100,000 |
| Engineering & Contingencies | 101,100,000 | 96,000,000 | 103,300,000 |
| Total | $390,000,000 | $370,400,000 | $398,400,000 |

## TABLE 10.4.1-10

## SECONDARY TREATMENT
## OPERATION & MAINTENANCE
## COST COMPARISON
## ($/YR)

| | Air Activated Sludge | Oxygen Activated Sludge | Coupled System |
|---|---|---|---|
| 1. Salaries & Wages | | | |
| Operation | 600,000 | 870,000 | 600,000 |
| Maintenance | | | |
| Subtotal | 1,590,000 | 1,860,000 | 1,590,000 |
| 2. Power | | | |
| Aeration Equipment | 2,180,000 | 2,320,000 | 2,460,000 |
| RAS and WAS Pumps and Sludge Collection | 480,000 | 580,000 | 480,000 |
| Subtotal | 2,660,000 | 2,900,000 | 2,940,000 |
| 3. Equipment Maintenance | | | |
| 4. Air Emission Control | 270,000 | 30,000 | 400,000 |
| Total Operation and Maintenance Annual | $5.620.000 | $5.850.000 | $6.040.000 |

Secondary Sedimentation

Secondary clarifiers separate the mixed liquor solids from the liquid flow. The clarified effluent, now low in suspended solids and BOD, is disinfected and discharged to the plant outfall. Settled solids are returned to the aeration reactor, in order to maintain the proper MLSS concentration and solids retention time in the reactor. Excess solids are wasted from the activated sludge process as waste activated sludge (WAS).

The secondary sedimentation alternatives that were recommended for detailed evaluation, as discussed in Section 8.5, were conventional rectangular clarifiers and stacked rectangular clarifiers. These alternatives were selected for detailed evaluation primarily because of their efficient land use and their treatment reliability.

Preliminary layouts of the planned treatment plant on the Deer Island site in Section 9.3 showed that conventional rectangular clarifiers are not a viable primary sedimentation alternative, due to area constraints. Therefore, the use of stacked rectangular clarifiers was the only alternative considered, and is described in detail in Section 11.0, Recommended Plan.

### 10.4.2 EVALUATION OF ALTERNATIVES

The following is an evaluation of the three secondary treatment alternatives described above: air activated sludge, oxygen sludge, and the coupled system -- all of which are used in conjunction with stacked secondary clarifiers. The rating of the alternatives for each of the evaluation criteria follows.

Environmental Criteria

Air Emissions

Air emissions control is required for all of the alternatives. Reactors are covered to control air emissions, and vent air is treated in a two-stage system consisting of a packed tower chemical scrubber followed by carbon adsorption. Vent air is forced through the packed tower against a counter-current flow of scrubbing liquid. This stage removes most of the potentially odorous compounds by oxidation, primarily $H_2S$. The vent air is then passed through the carbon adsorption column, which removes the remaining odors and the volatile organic compounds (VOCs). Prior to carbon adsorption, the air stream must pass through a demister. The size of the emissions control equipment depends on the quantity of air flow expected under peak flow conditions.

The air activated sludge basins were costed with air-tight, low profile concrete decks which are less expensive than fiberglass covers. It has been assumed that, for this sytem, the quantity of air supplied is equivalent to the quantity of air requiring treatment. The air is supplied to the reactor through fine bubble, diffused air aeration equipment. Peak air flow has been estimated at approximately 280,000 scfm, while average air flow has been estimated at approximately 120,000 scfm.

During peak and average conditions, the oxygen activated sludge process produces approximately 6000 scfm and 3000 scfm of vented gas, respectively, which is only 2 percent of that produced by the air activated sludge system. The reduced air flow is due to several factors. Introducing a gas that is 95 percent pure oxygen, as opposed to 21 percent oxygen, results in less air flow and more efficient oxygen transfer. Nitrogen gas, which is not easily soluble and requires treatment, is nearly absent in the oxygen system, as compared to its presences in the air system. Much of the gas introduced to the oxygen system exits the system in the dissolved state, rather than as vented gas, further reducing the quantity of air to be treated. Since the oxygen system is controlled by the pressure in the reactor, the air emissions control system must be designed so that the last reactor is not disrupted.

Air emissions control for the coupled system is more complex than it is for the air system, because both the trickling filters and the aeration basins must be covered. The aeration tanks are covered with air-tight concrete decks, while the trickling filters are capped with fiberglass domes. It is recommended that the vented air from the aeration tanks serve as the air supply for the trickling filter, and that an air recycle line from the trickling filter exhaust to the trickling filter intake be incorporated into the system. This design significantly reduces the quantity of air to be treated, compared to the quantity that must be treated in a once-through system. Approximately 340,000 scfm and 200,000 scfm of air require treatment under peak and average flow conditions, respectively.

At present, air emissions standards, particularly for toxics, are in a state of flux. As air emissions limits become more stringent, control of air emissions will become increasingly complex and expensive. Since the required control of air emissions remains somewhat uncertain, the alternative that generates the smaller amount of vent air, thus requiring the smallest control facility, offers significant advantages. The oxygen activated sludge alternative generates only 2 percent of the vent air volume that is produced by the air activated sludge and coupled system alternatives, and, therefore, offers a definite advantage over these alternatives.

The site preparation and construction activities for the three secondary treatment alternatives are similar. Therefore, air emissions control required during construction is considered equal for all of the alternatives.

Noise Control

The purpose of the noise control engineering analysis was to evaluate the noise produced from each alternative, to determine the noise control required to maintain stipulated noise levels at off-site receptors. This evaluation was performed by estimating the noise level of each alternative at the nearest residence, located on Tafts Avenue, Point Shirley (approximately 2200 ft north of the existing main pumping station on Deer Island). A preliminary judgment was then made on the relative impact of the noise. Where the predicted sound levels exceeded target levels, appropriate noise mitigation facilities were incorporated into the prediction.

The existing daytime ambient noise level at the nearest residence was previously measured as 45 dBA, and the nighttime ambient as 39 dBA (see Appendix D). The design goal of this analysis was to incorporate sufficient noise control to keep the estimated noise levels less than, or equal to, the existing nighttime residual ambient sound level of 39 dBA at Point Shirley.

The level of effort for noise mitigation was categorized as follows: If equipment is to be enclosed in a building for weather protection, and the noise predictions indicate that acoustical material will be required on the walls and ceiling and the ventilation will have to be quieted, this would be classified as a modest amount of noise control. If more expensive construction is required to contain the noise, such as the use of double wall insulated steel, sound proof doors and custom exhaust mufflers, etc., this would be classified as a difficult requirement. If no significant noise control is required, these requirements would be categorized as minimal.

In the evaluation of the secondary treatment alternatives, the air compressors, mixers, and cryogenic oxygen generation plant were the major concerns with respect to noise. The air activated sludge alternative includes air compressors and their drive motors, which will be housed in the compressor building. The primary sources of noise for this alternative are the compressor's inlet and casings. The compressor casing noise for compression, totaling 27,500 hp, was estimated and corrected for the transmission loss caused by building with noise absorption materials on the inside. Subsequent hemispherical spreading and atmospheric absorption results in a projected sound level at the nearest receptor of 18 dBA. For simplicity, the distance to the nearest receptor was assumed to be the same as the distance from the compressor building to the existing diesel building (2200 ft).

The predicted compressor inlet noise of 54 dBA was controlled with large intake silencers to 20 dBA. The total noise of the compressor case and intake noise is 22 dBA at the nearest receptor. The noise control engineering required to attain these levels was ranked as modest. Where pump noise was predicted, it was assumed that the major source of noise was the motor. Motor noise was predicted on the basis of motor horsepower.

For the oxygen activated sludge alternative, noise emissions were estimated based on the horsepower for both the compressor intake and compressor casing, mixers, and existing data from other oxygen generation plants. It is assumed for this analysis that the exhaust noise is controlled by the piping.

The cryogenic oxygen generation plant is a potential source of noise in the oxygen activated sludge system, particularly for the prepurifier process in which water vapor, carbon dioxide, and hydrocarbons are removed from the air. This process can be accomplished in two ways: by a reversing heat exchanger; or by a molecular sieve. In both cases the system requires purging to prevent clogging. The purge cycle typically runs six to eight times per hour for the reversing heat exchanger, and once every 8-12 hours for the molecular sieve system. Silencers can be installed on the prepurifier, limiting the noise generation. Site visits at existing

cryogenic plants with reversing heat exchangers indicated that noise levels increased from 80 dBA to 90 dBA when the system purged.

The oxygen activated sludge alternative incorporates four compressors for the cryogenic system, totaling 12,000 hp -- 3500 hp being the maximum horsepower required at any one time. Their noise level was predicted, in the same manner as above, to be 18 dBA at the nearest receptor. The dissolution equipment consists of 36 mechanical aerators with outdoor electric motors totaling 4200 hp. Their expected sound level is approximately 36 dBA. Partial enclosures or silencers may be required to lower this level to 30 dBA. The noise control engineering required to attain these levels was ranked as modest.

The coupled system has a total compressor horsepower of 17,500 and an additional 7200 hp of wastewater pumping capacity, both housed in buildings. The noise levels were predicted in the same manner as above, giving a nearest receptor noise level of 21 dBA. The noise control engineering effort required to attain these levels was ranked as modest.

Visual Impacts

On-site earthen berms will be constructed to elevation 210 ft, specifically to reduce visual and noise impacts on the neighboring population. Because of this, the three secondary treatment alternatives create similar visual impacts. In all cases the reactors are covered, aiding in the reduction of adverse visual impacts. The coupled system circular packed towers will be covered with fiberglass domes and would have a water surface elevation of 165 ft. They would be located at the center of the site. The two cryogenic oxygen generation towers will reach to elevation 225 ft while the blower buildings will reach to about elevation 175 ft. All three alternatives have been rated as minimal with regard to visual impact.

Environmental

Other environmental criteria which were used to compare the potential impacts of the alternative facility concepts include the following land resources:

- Historic and archaeological sites
- Floodplains, wetlands, and barrier beaches
- Wildlife and endangered species

For the secondary treatment alternatives retained for detailed analyses, there were no significant differences in these three criteria among alternatives. This resulted in the choice of alternatives being based on the following qualitative differences:

- All of the conceptual plans for the three alternatives are restricted by the boundaries of the cemetery. Site layouts for all alternatives are similar in area requirements and physical location of facilities.

- o All processes have the same potential for impacting each of the historic structures.

- o All processes have the same potential for impacting the floodplain.

- o While no rare and endangered or threatened plant or animal resources have been identified on Deer Island, the potential for impacts on species such as the American peregrine falcon, which could visit Deer Island, would be common to each of the alternative treatment processes.

- o No difference exists among the potential buffering opportunities afforded by the alternatives.

Conceptual site plans for all three alternatives are restricted in their placement by the need to preserve archaeological sites. The possibility for adaptive reuse of all or part of the Hill Prison structure is limited for each of the alternatives. None of the alternatives directly affects the Prison Superintendent's House, the Queen Anne-style farmhouse, or the old steam pumping station.

The overall environmental criteria evaluation for each of the alternatives shows that each is judged to have a "modest" effect.

Traffic

The three secondary treatment alternatives evaluated will have similar requirements with respect to the number of truck trips and barge trips for personnel, materials, and equipment during construction and operation.

The oxygen system has a slight advantage with respect to quantities of excavated materials, construction fill, and concrete required, since the total tankage (aeration and secondary clarifiers) is slightly smaller for this alternative.

During operation, traffic generated by the secondary treatment facility will be a function of the number of operation and maintenance personnel required, hydrogen chloride gas requirements, and the quantities of sludge to be removed from the island. The oxygen generation system requires 62 operation and maintenance personnel over 3 shifts, compared to 53 over 3 shifts for both the air activated sludge and the coupled system. The oxygen system is expected to produce slightly more waste activated sludge, 130 tons per day (tpd) (7 trucks), versus 119 tpd (6 trucks) for the air activated sludge and coupled system alternatives. However, neither of these differences is great enough to produce a significant difference in traffic flow.

Of the three secondary treatment alternatives under consideration, the coupled system and the air activated sludge system require the delivery of hydrogen chloride (HCl) gas to Deer Island, for the cleaning of the ceramic diffusers. However, as previously discussed in Section 8.2.3, oxygen activated sludge could be used in the coupled alternative, eliminating the need for the

gas cleaning. Hydrogen chloride gas is similar to gaseous chlorine in its characteristics and handling requirements. The estimated quantity required would be 34,000 to 50,000 lb/yr for air activated sludge, and 22,000 to 32,000 lb/yr for the coupled system. Delivery of 34,000 lb/yr in 600-lb cylinders would require six truck trips via barge per year.

The delivery of HCl gas by truck, rail, or barge would be made in accordance with U.S. Department of Transportation requirements for the transportation of hazardous materials.

The potential transportation impacts associated with construction and operation of all three alternative secondary treatment processes are consistent with the phased activities presented in MWRA's Final Facilities Plan Report for On-Shore Water Transportation Facilities, April, 1987. Traffic impacts associated solely with the alternative secondary treatment processes are judged to be modest.

Technical Criteria

Area Requirements

Preliminary layouts for the three secondary unit processes under consideration were prepared and area requirements were estimated for each (refer to Section 9.0, Alternative Site Planning).

In all cases the layouts included space between the multiple units, interprocess conveyance, and allowances for roadways and ancillary facilities. The estimated land area for each of the alternatives includes the area needed for stacked secondary clarifiers.

The air activated sludge alternative consists of four aeration basin batteries, each with a total surface area of 3.1 acres. The four batteries of stacked secondary clarifiers associated with the process occupy 27 acres. A blower building sized at 150 ft by 180 ft is required to house the necessary aeration equipment. Allowing for the required space between units and interprocess conveyances, the total area requirement for this alternative is about 42 acres.

The coupled system, consisting of sixteen 140-ft-diameter trickling filters and four batteries of aeration basins, requires a total surface area of 21 acres. Ancillary facilities for this alternative include a pumping station and blower building. Area required for stacked secondary clarifiers for the coupled system is 27 acres. The total area for this alternative is about 48 acres.

The oxygen activated sludge alternative requires slightly less area than the air activated sludge alternative. This is because the reactor volume is smaller, requiring only 1.7 acres per battery. The stacked secondary clarifiers for this alternative cover a slightly larger area of 29 acres, since the overflow rate for this process is slightly less than that required for the air system. Oxygen generation equipment, including the two cryogenic units, liquid oxygen storage, compressor building, and an area for secondary treatment operation and maintenance, requires approximately one acre. Total area for this system is about 39 acres.

The air and oxygen activated sludge alternatives should be considered equal with respect to area requirements. The three-acre difference, based on layouts and sizing criteria used herein, is negligible. Slight revisions in sizing criteria and/or tank geometry (including depth) could reduce or eliminate this slight difference.

The activated sludge alternatives offer additional open space compared to the coupled system, and provide visual buffering at the northern end of the island.

Reliability/Flexibility

The differences in equipment required for the air activated sludge and oxygen activated sludge alternatives lie in their aeration/oxygenation equipment and controls. The air activated sludge process has highly reliable components for compressing air. In addition to the inherent reliability of the equipment, a significant amount of standby equipment has been incorporated in the design. Eleven compressors have been supplied, with only three necessary for average day loading. At peak loading conditions seven compressors are required, providing nearly forty percent standby. The fine bubble diffuser gas cleaning system and proper maintenance will keep the oxygen transfer efficiency of this system at or near its design point. The dissolved oxygen probes utilized in this sytem would require routine, frequent cleaning and calibration to maintain reliable readings.

The aeration system has been sized to operate at an F/M of 0.55 and a hydraulic detention time of 1.85 hours, for flows and loadings expected at average high groundwater conditions. The secondary clarifiers have been sized around an overflow rate of 700 gpd/$ft^2$ at average high groundwater conditions. At maximum organic loading conditions, enough air will be supplied to satisfy uptake demands, while maintaining minimum dissolved oxygen levels at 2.0 mg/l. Air supply to the discharge end of the aeration basins may be mixing limited, rather than oxygen demand limited. Minimum air required to maintain adequate mixing of the MLSS is 0.12 scfm/$ft^2$ of aeration basin area. Air activated sludge is rated high for reliability/flexibility.

Oxygen generation for the Deer Island Treatment facility will be accomplished through two separate cryogenic plants, each sized at 100 percent of required capacity. One cryogenic oxygen generation plant is supplied to meet oxygen requirements, with peak oxygen requirements provided through on-site liquid oxygen generation. The cryogenic plant requires a scheduled annual overhaul to keep the plant in good working order. The second plant is brought on-line prior to taking the operating plant out of service. Generally, it requires three to four days for a "moth-balled" cryogenic plant to cool down and become operational. However, if liquid oxygen is used in the start-up, this time can be reduced to 24 hrs. The liquid oxygen required for start-up is approximately 50 to 70 percent of the plant's capacity. Unscheduled interruption of the cryogenic plant results in an automatic changeover to LOX. Sufficient LOX storage capacity is supplied to handle peak loading demands, oxygen requirements for plant turnaround, and requirements in the event of unscheduled interruption of the gaseous oxygen supply.

Four compressors are supplied with the oxygen system, all of which are able to operate with both cryogenic plants. Two compressors with 100 percent capacity and two compressors with 70 percent capacity provide 50 percent standby. The equipment redundancy for the oxygen generation system equals or exceeds that for the other secondary treatment alternatives.

The oxygen system's mechanical aerators can be maintained without entering the aeration basin. Extra aerators would be stored on-site to minimize downtime if significant maintenance is required. All equipment for the pure oxygen system is serviceable without draining the system. The system utilizes a highly reliable pressure switch to control oxygen flow. Overall, the process is also rated high for reliability/flexibility.

The coupled system has been found to be a reliable process for secondary treatment of wastewater and is also ranked high. However, the performance of the trickling filter is influenced by the quality of the primary effluent. An increase in the suspended solids concentration in the primary effluent significantly reduces the BOD removal achieved in the trickling filters. The activated sludge systems are not significantly impacted by variations in the quality of the primary effluent. The pumping equipment and aeration equipment required for the coupled system is provided with 40 percent redundancy at peak flow.

Constructibility

The site preparation and civil work associated with the construction of the three alternatives is a function of the tankage and area requirements. As discussed previously, the oxygen system has a slight advantage in this regard, because the least volume of excavation is required. The cold boxes for the oxygen activated sludge system can be shop fabricated and barged to the site where they will be erected and piped. The liquid oxygen storage tank will be field fabricated. Construction of the stacked secondary clarifiers will be the same for each alternative, and should not cause any special construction concerns.

All three alternatives are rated as minimal for constructibility.

Personnel Safety

The gas cleaning system for the ceramic disc, fine bubble diffused air system in the air activated sludge and coupled systems periodically uses anhydrous hydrochloric acid. This is a hazardous chemical, and requires special safety precautions for operation. Newer diffuser technology, available at the time of design, might not require this gas cleaning system.

The pure oxygen system requires on-site storage of liquid oxygen. Although oxygen is not flammable, it more readily supports ignition and combustion of materials as compared to air. Liquid oxygen must be stored in a well-ventilated area to avoid the collection of oxygen in the event of system leaks. Personnel must not smoke in the vicinity of the liquid oxygen area. A detection device that senses hydrocarbon concentration is built into the aeration tanks. Should high concentrations of hydrocarbons (such as gasoline) appear, the oxygen feed and

aerators automatically shut down and the space above the liquid surface is purged with air. This system has been extremely reliable in the prevention of explosions.

The three alternatives are considered to require a typical level of safety precautions in order to reduce risks to plant personnel and the surrounding community.

Staffing Requirements

Staffing requirements for the various secondary treatment alternatives have been determined by analysis of staffing at existing large wastewater treatment facilities, discussions with manufacturers of the various equipment and facilities under consideration, and discussions with members of the MWRA Operations Review Committee.

It is estimated that five supervisors, five operators, five attendants, and five laborers would be required to operate the air activated sludge process on a twenty-four hour, 7 day per week schedule. The coupled system is expected to require the same number of personnel as the air activated sludge system. The number of personnel required to operate the oxygen system would require the above-mentioned employees, plus the following personnel to operate the cryogenic oxygen production facility: one oxygen production supervisor; one oxygen production foreman; five operators; and two attendants.

Thirty-three maintenance people are required for each of the three secondary treatment alternatives.

Total operation and maintenance staff required for the air activated sludge system and coupled system is 53. The oxygen air activated sludge system requires a total operation and maintenance staff of 62. In addition, it has been assumed that an annual overhaul of the cryogenic generation equipment would be done by contract services.

Operational Complexity

Operation of any of these three biological systems requires trained and experienced personnel, but the systems are approximately equivalent in operational complexity.

The oxygen generation system requires a higher degree of operator training compared to air activated sludge, but is automated and requires little operator attention, other than taking periodic readings. It will require a skilled electrician to maintain the instrumentation in this sytem. Maintenance of the compressors and appurtenances may be done by mechanics, but the cryogenic system should be maintained by the manufacturer. Cost estimates for the oxygen system include a yearly maintenance contract. Both the air and oxygen activated sludge systems are rated typical. The coupled system is considered slightly more complex to operate. since two biological processes are involved rather than one. Operators must be trained in the process control of both fixed-film and suspended growth systems. However. the skills required for operation are still rated typical.

Power Needs

Estimated power requirements are similar for the three secondary treatment alternatives. The air activated sludge process requires approximately 5530 kw to operate the blowers, the return and waste activated sludge pumps, and the sludge collection equipment on an average day, and 13,600 kw during peak conditions. The oxygen activated sludge system requires less power to operate the dissolution equipment, due to the increased oxygen utilization rate and type of aeration equipment used, but additional power is required to operate the oxygen generation equipment. The total power requirement for this process on an average day is 6020 kw, and on a peak day is 9400 kw, including sludge collection and pumping. In addition to the aeration and sludge collection power requirements, the coupled system must pump the primary effluent to the trickling filter. Therefore, power requirements are slightly higher for this alternative, at a total of 6100 kw on the average day, and 14,700 kw for peak conditions.

Chemical Requirements for Operation

Approximately every nine months, the fine bubble ceramic diffusers require cleaning with anhydrous hydrochloric acid. For the air activated sludge system, approximately 34,000 pounds are required per year. The coupled system requires 22,000 lb/yr. Actual quantities would be dependent on the rates at which oxygen transfer decreases and blower pressures increase. Existing well-operated ceramic diffuser facilities indicate that cleaning will be required approximately every nine months. As previously discussed, oxygen activated sludge could be used with the coupled system, and would eliminate the need for gas cleaning in this case. Newer diffuser technology available at the time of design might not require this gas cleaning system. The oxygen system does not require any chemicals for operation.

Quantity of Residuals

The quantity of residuals produced in an activated sludge system is dependent upon the operational F/M ratio. The quantity of sludge produced for the air and coupled system is identical, and is estimated at 119 dry tons per day. Since the pure oxygen activated sludge system operates at a higher F/M ratio, it will produce approximately 130 dry tons of sludge per day.

Quality of Residuals

The quality of the residuals for the three systems is considered equal, since all alternatives treat the same influent. Since the characteristics of the secondary sludge will not differ among the alternatives, the impacts associated with processing and disposing of the sludge will be identical.

Quantity and Quality of Spoils for Disposal and/or for Relocation

The total volume of spoils disposal and/or relocation are presented below:

| | |
|---|---|
| Air Activated Sludge | 1,800,000 $yd^3$ |
| Oxygen Activated Sludge | 2,000,000 $yd^3$ |
| Coupled System | 2,500,000 $yd^3$ |

The volumes include spoils from construction of the stacked secondary clarifiers.

All three secondary facilities alternatives would be located in the same general vicinity, and the quality of spoils is expected to be the same. The material is largely glacial till.

Timely Implementation

The relative difficulty expected in maintaining the installation schedule for all three secondary treatment alternatives has been rated as modest. While each of the system technologies presents a number of complexities, there are several factors that tend to limit the extent to which these would make one option any more or less desirable than another.

The vast majority of the components in all of the options comprise structures and equipment commonly used in the wastewater treatment process industry. However, the quantity of equipment required may produce unique problems and delays. Equipment orders and purchases must be carefully scheduled to allow the manufacturing of the required quantities of equipment in the required time frames.

The cryogenic oxygen generation system would be fabricated and completely assembled off-site and barged to Deer Island. The cryogenic system might be easier to obtain and install on schedule, since the two large, complete systems provided by the vendor would require less coordination than the numerous quantities of equipment associated with the air activated sludge and coupled systems.

Permitting

All three alternatives are equal with respect to their potential impact on the permitting process, and have been rated as modest. All three can be designed to ensure the ability of the plant to meet the required effluent limitations. Further, each can be designed to ensure compliance with any applicable noise and/or air pollution control requirements.

External and Internal Coordination Requirements

The extent to which all of the proposed options will pose significant coordination requirements is judged to be moderate. In part, this is because the construction of the selected secondary treatment facilities will not commence until the new primary units are completed, and the existing primary facility has been razed. This phasing will reduce many of the coordination needs between contractors and vendors that might otherwise be present, as well as the logistical problems of staging materials and suppliers for all phases of the project at one

time. The fact that the cryogenic oxygen generation units are supplied as a "package" could reduce the required internal coordination.

Demand for Unique or Scarce Construction Resources

The site characteristics, the need for water transportation, and large competing construction projects in the Greater Boston area, such as the third harbor tunnel and the depression of the Central Artery, place all three alternatives in the difficult category. The harbor tunnel and Central Artery projects are likely to limit the availability of qualified laborers. The need to transport materials and equipment to Deer Island by barge or boat will require a sizable number of specially equipped vessels, and on- and off-loading facilities, as well as special labor capabilities to staff these functions.

The ability to find and/or train a sufficient number of qualified system operators to facilitate the project start-up and subsequent shake-down operations may also be a problem regardless of the technology chosen.

Flexibility to Meet Future Changes

All three secondary treatment unit processes have the capacity to be modified to incorporate nutrient removal, if necessary. However, in the air and oxygen activated sludge systems it would be easier to implement biological nutrient removal than in the coupled system. The ability to treat significant increases in flows and loadings is limited for all processes, due to the site constraints.

Cost Criteria

Capital Costs. A breakdown of the relative capital costs for the three secondary treatment alternatives was presented in Table 10.4.1-9. These costs include structures, equipment, instrumentation, air emissions control equipment, and noise control equipment. Thirty-five percent has been added to the capital costs to account for construction contingencies, administrative, engineering and legal costs. As previously discussed, these are relative capital costs developed for the comparison of alternatives. As such, costs for common items, such as interprocess conveyance, control buildings, roads, etc., have not been included.

Operation and Maintenance Costs. A breakdown of the operation and maintenance costs was presented in Table 10.4.1-10. These costs include salaries and wages for all necessary operation and maintenance personnel, power chemicals, spare parts, and equipment maintenance.

Present Worth Costs. Present worth costs have been calculated using the life cycle factors developed in Section 4.4. The cost analysis shows that the pure oxygen system is the least costly alternative at $224,000,000, followed closely by the air activated sludge system at $234,000,000. The coupled system is the most costly at $240,000,000. However, the cost difference is less than 10 percent. Since planning-level cost estimates are accurate within a

range of 10 percent more or less than actual costs, the three alternatives should be considered equal in cost and the selection of the recommended process should be based on non-cost factors.

A cost sensitivity analysis was conducted for labor and energy, to determine how the present worth cost might vary among alternatives. The analysis produced insignificant changes in the present worth cost difference among the alternatives.

Evaluation Matrix

Table 10.4.2-2 summarizes the evaluation of secondary treatment alternatives.

## 10.4.3 SELECTION OF RECOMMENDED SECONDARY TREATMENT FACILITIES

The three alternatives evaluated for secondary treatment -- air activated sludge, oxygen activated sludge and the coupled system (packed tower followed by activated sludge) -- have similar capital costs, operating costs, and life cycle costs. Power consumption is nearly equal among the three alternatives; therefore the cost comparison will be unaffected by potential future increases in energy costs. Of the three alternatives, the coupled system has the greatest capital cost, operation cost, life cycle cost, and power consumption.

The three alternatives can also be considered equal with regard to potential noise impacts on neighboring homes, constructibility, reliability, effluent quality, and residual quantity and quality. The air and oxygen activated sludge systems can be considered equal with regard to area requirements, while the coupled system is slightly more area-intensive.

Operationally, the coupled system is slightly more complex, as the process requires control of two biological systems. Since the coupled system offers no distinct advantage over the activated sludge alternatives, and had the highest costs and power consumption, it was eliminated from further consideration.

Thus, the recommended secondary component of the Deer Island Treatment Facilities consists of an activated sludge process utilizing stacked, rectangular clarifiers. Oxygen for the biological stabilization process in the activated sludge system could be provided by air,or by oxygen generated in a cryogenic unit. In order to select between air and pure oxygen as the means of introducing oxygen into the activated sludge system, the air and oxygen activated sludge alternatives were evaluated in further detail for operability and reliability under service conditions expected at Deer Island.

Operability and Reliability

Due to the nature of the MWRA collection system, the secondary treatment plant at Deer Island will be subjected to highly variable flows and loads. The ability to successfully treat these variations is an important parameter in selecting air or oxygen activated sludge. Oxygen activated sludge systems have an inherently greater capability to handle large variations in loadings than do air activated sludge systems.

## TABLE 10.4.2-2

## SECONDARY TREATMENT UNIT PROCESS EVALUATION OF ALTERNATIVES

| Criteria | Air Activated Sludge | Oxygen Activated Sludge | Coupled System | Remarks |
|---|---|---|---|---|
| ENVIRONMENTAL | | | | |
| Air Emission Control (scfm peak and average) | 280,000<br>120,000 | 6,000<br>3,000 | 340,000<br>200,000 | Oxygen activated sludge has a distinct advantage in the control of odors and volatile organic compounds compared to other alternatives. |
| Noise Control | Modest | Modest | Modest | Most equipment is enclosed in buildings. Noise levels can be kept below the ambient sound levels. |
| Visual Impact | Minimal | Minimal | Minimal | Earthen berms will be constructed to significantly reduce visual impacts. |
| Environmental Criteria | Modest | Modest | Modest | All three alternatives require about the same area and impact land resources equally. |
| Traffic | Modest | Modest | Modest | The on-island and off-island pier facilities are planned to minimize land and marine traffic impacts. |

TABLE 10.4.2-2

SECONDARY TREATMENT UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| Criteria | Air Activiated Sludge | Oxygen Activated Sludge | Coupled System | Remarks |
|---|---|---|---|---|
| TECHNICAL | | | | |
| Area Requirements including secondary clarifiers (acres) | 42 | 39 | 48 | Area requirements for air and oxygen activated sludge can be considered to be equal. |
| Reliability/Flexibility | High | High | High | All three systems are well proven treatment technologies and are provided with sufficient system redundancy. |
| Constructability | Minimal | Minimal | Minimal | None of the alternatives introduce any atypical construction concerns. |
| Personnel Safety | Typical | Typical | Typical | |
| Staffing Requirements (No.) | 53 | 62 | 53 | Oxygen activated sludge requires slightly more operators because of the cryogenic oxygen production facility. |

TABLE 10.4.2-2

SECONDARY TREATMENT UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| Criteria | Air Activated Sludge | Oxygen Activated Sludge | Coupled System | Remarks |
|---|---|---|---|---|
| Operational Complexity | Typical | Typical | Typical | Maintenance of the cryogenic unit should be performed under a service contract with the manufacturer. |
| Power Needs (avg/peak) (Kw) | 5530/13600 | 6020/9400 | 6100/13500 | Power needs are similar for all these alternatives. |
| Chemical Requirements for Operation (lb HCl/yr) | 34,000 | None | 22,000 | Anhydrous hydrochloric acid gas is required for cleaning fine bubble diffused air systems. |
| Quantity of Residuals ($yd^3$ at avg. high groundwater) | 119 | 130 | 119 | Oxygen activated sludge produces about 10 percent more waste activated sludge solids than the other two alternatives because of a higher F/M ratio. |
| Quality of Residuals | Typical | Typical | Typical | All three alternatives treat the same influent and the characteristics of the waste activated sludge are expected to be similar. |
| Quantity and Quality of Spoils (yds) | 1,800,000 | 2,000,000 | 2,500,000 | Quality of spoils is expected to be about the same for all these alternatives (glacial till). |

TABLE 10.4.2-2

SECONDARY TREATMENT UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| Criteria | Air Activated Sludge | Oxygen Activated Sludge | Coupled System | Remarks |
|---|---|---|---|---|
| INSTITUTIONAL | | | | |
| Timely Implementation | Modest | Modest | Modest | Due to the large quantities of equipment required, careful scheduling will be required for all alternatives to ensure timely implementation. |
| Permitting | Modest | Modest | Modest | All three systems can be designed to comply with air/noise/effluent disposal permits. |
| External and Internal Coordination Requirements | Moderate | Moderate | Moderate | Construction of secondary treatment facilities will not begin until of the primary plant is placed in operation. |
| Demand for Unique or Scarce Construction Resources | Difficult | Difficult | Difficult | The third harbor tunnel and Central Artery projects are likely to limit the availability of qualified laborers for all alternatives. |
| Flexibility to Need Future Change | Fair | Fair | Fair | Spatial limitations reduce flexibility available to meet increased flows and loads for all alternatives. Biological phosphorus removal could be implemented in air or oxygen activated sludge systems. |

TABLE 10.4.2-2

SECONDARY TREATMENT UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| Criteria | Air Activated Sludge | Oxygen Activated Sludge | Coupled System | Remarks |
|---|---|---|---|---|
| COST | | | | |
| Capital Costs (millions of dollars) | 390 | 370 | 399 | Capital costs include costs of secondary clarifiers. |
| Annual Operation and Maintenance Costs (millions of dollars) | 5.6 | 5.9 | 6.0 | Annual operating costs slightly favor the air activated sludge alternatives. |
| Present Worth Costs (millions of dollars) | 234 | 224 | 240 | All three alternatives should be considered equal in present worth costs. |

The Metropolitan Denver Sewage Disposal District No. 1 conducted a 15-month side-by-side performance evaluation of air and oxygen activated sludge using its 100 mgd air activated sludge and 72 mgd oxygen activated sludge systems (Nelson & Puntenney, 1983). As a result of the evaluation, the district concluded that well-designed air or oxygen systems will produce similar results. However, they also concluded that oxygen is the ideal system in cases where large diurnal variations in organic loadings must be handled. The oxygen system exhibited significantly less sensitivity to variations in organic loading and F/M ratio.

The Southeast Plant in San Francisco, California utilizes oxygen activated sludge to provide secondary treatment to about two-thirds of the city. The plant has an average day design capacity of 85 mgd and a peak design capacity of 142 mgd. The plant receives flows from a combined system; consequently the flows are highly variable. Daily flows exceed 100 mgd about 40 times per year. The plant has produced an exceptionally stable effluent, averaging 15 mg/l TSS and BOD in 1986. During an eleven day period of rain in February 1986, when average flows to the plant were 126 mgd, the plant effluent never exceeded 25 mg/l BOD and 18/mg/l TSS, and averaged 8 mg/l BOD and 12 mg/l TSS. The plant has also exhibited considerable resiliency to high chloride concentrations. Chlorides normally average about 1100 mg/l. During a six day period in early 1987, chlorides spiked to over 5700 mg/l, and were greater than 4000 mg/l for three days in succession. Effluent BOD never exceeded 45 mg/l, and reduced to less than 20 mg/l within two days of the return to normal chloride concentrations.

The East Bay Municipal Utility District in Oakland, California operates an oxygen activated sludge plant treating an average flow of 83 mgd. The plant is subjected to high seasonal loadings due to food processing and to sudden peaks in flow and organic loadings during wet weather. The oxygen activated sludge system has been operated at an SRT of less than 2 days for over one year. Plant personnel reported that the system has demonstrated resiliency in dealing with sudden, storm-related peaks while operating at the low SRT. The oxygen system has also demonstrated considerable ability to withstand toxic upsets.

Oxygen systems have a proven track record in successfully handling large variations in organic loadings. Very high and variable organic loads at the front end of an oxygen system are not a problem. Oxygen has an inherent ability to handle high, variable uptake rates, and the mechanical mixers used for oxygen dissolution in the oxygen basins are not subject to fouling and loss of transfer efficiency. High, variable oxygen uptake rates in a fine bubble, air activated sludge system are of considerable concern. Peak, sustained uptake rates in excess of the maximum transfer capability of the system can result in biological sliming or fouling, and serious loss of oxygen transfer capacity. If not immediately corrected, this loss of transfer efficiency can spread the length of the aeration tanks. The oxygen system has a clear advantage over the air system in its ability to handle variable loads of the nature expected at Deer Island.

Operationally, the air and oxygen systems are essentially identical in terms of process control. However, in terms of maintenance and non-biological process aspects of operation, they are very different.

A major factor in the efficient operation and control of a fine bubble diffused air system is the visual appearance of the aerated water surface. Diffuser fouling and/or air leaks become apparent via a change in the aeration pattern on the water surface. This important control aspect will be eliminated, or seriously impaired, in the covered aeration basins required at the Deer Island plant. The Milwaukee Sewerage District has several uncovered fine bubble aeration tanks, and one covered fine bubble aeration tank at its Jones Island Treatment Plant. District personnel indicated that the covered basin is only used under extreme conditions, due to the difficulties associated with operation and maintenance.

Fine bubble air systems are subjected to a normal loss of transfer efficiency due to internal and/or external clogging. To rectify this, and to return the system to original transfer capabilities, the diffusers must be periodically cleaned. Well-designed and operated fine bubble plants have demonstrated that each diffuser should be cleaned about every 9 months. Capital and operating costs presented for the air activated sludge system include an in-situ gas cleaning system for the diffusers. The gas cleaning system uses anhydrous hydrochloric acid. This gas has properties and handling requirements similar to those of gaseous chlorine. Approximately 35,000 pounds per year of anhydrous hydrochloric acid would be required. Given the large number of diffusers required at Deer Island, cleaning would probably be performed in various segments of the plant during different periods of the year. Actual cleaning operations, and the associated handling of the hydrochloric acid, would probably be limited to no more than 3 to 4 months per year. There are alternate means of cleaning fine bubble diffusers rather than the in-situ method. However, these are very labor-intensive, still require the use of cleaning acids, and require hand cleaning of each diffuser. This would be very unattractive in the closed aeration tanks required at Deer Island. The EPA Summary Report on Fine Pore (Fine Bubble) Aeration Systems (EPA/625/8-85/010, October 1985) states "...there is little doubt that the incorporation of an effective diffuser cleaning schedule is a necessary and justifiable component of any fine pore diffused aeration preventive maintenance program." Alternative diffusers to the ceramic fine bubble units developed to date, such as the flexible membrane units, have exhibited similar fouling characteristics to the ceramic units in side-by side testing. Hand cleaning, or replacement, is required to restore transfer efficiency to these diffusers. The periodic diffuser cleaning and the use of the cleaning gas would not be required in the oxygen system.

The cryogenic oxygen generation system is unquestionably a highly instrumented process requiring efficient and highly-trained operators. Additional personnel to run the oxygen generation equipment, compared to the air oxygen activated sludge system, have been included in the cost analysis. These personnel could be recruited and trained by the MWRA, or the generation facilities could be run as contracted operations. The Manuals of British Practice in Water Pollution Control. Unit Processes. ACTIVATED SLUDGE (The Institute of Water Pollution Control. July 1987) points out that "...personnel employed in the operation of conventional plants do not usually experience undue difficulty with the sophisticated automatic equipment associated with oxygen processes." Yearly turn-around requirements at oxygen generation plants are typically achieved through contracted maintenance with the oxygen vendors. Costs for this

are included in the cost comparison. However, for the size of secondary treatment facilities proposed for Deer Island, the overall oxygen activated sludge system is no more operationally complex than the air system, and perhaps less so. The air activated sludge system includes eleven 2500 hp centrifugal blowers, 100,800 fine bubble diffusers in covered aeration tanks, air delivery and metering equipment, inlet air filtration equipment including eleven electrostatic precipitators, and exhaust air handling and treatment. The oxygen activated sludge system includes two 300 tpd cryogenic generators, one 1000 ton LOX storage tank, two 3500 hp inlet compressors and two 2500 hp inlet compressors, 48 mechanical surface aerators, oxygen delivery and metering equipment, and exhaust gas handling and treatment. The gas stream delivery system, exhaust system, and treatment system for the oxygen process are significantly smaller than those for the air system. Average gas flow in the air system is 120,000 scfm, while flow in the oxygen system is 3,000 scfm.

There is significantly less equipment associated with the oxygen activated sludge system as compared to the air activated sludge system. Most importantly, the air system contains more than 100,000 diffusers, which must be maintained in covered aeration basins. The oxygen system utilizes 48 mechanical aerators that can be maintained from the top of the covered oxygen basins by lifting the aerators with a mobile crane. Oxygen system operators report that maintenance personnel are seldom, if ever, required to enter the covered oxygen basins. Contrary to this, any maintenance on the fine bubble diffusers and associated piping will require operator entrance into the covered basins.

The MWRA Secondary Treatment Facilities Plan Operations Review Committee unanimously agreed that an oxygen activated sludge system would be preferred over air activated sludge with covered aeration basins. Given the level of equipment that must be maintained in each system, as well as the operational complexity associated with the covered aeration basins in the air activated sludge system, the oxygen activated sludge system is preferred from an overall operability standpoint.

Noise Generation

Treatment plant employees and surrounding neighbors must be protected from noise sources. Potential noise sources in the air activated sludge system include the air blowers, the air piping, and associated appurtenances. These sources can be controlled by equipping the blowers with inlet and discharge silencers, by installing the blowers in noise-deadening buildings, and by prudent design of the air piping and appurtenances. Potential noise sources in the oxygen activated sludge system include the inlet air compressors, switching valves on the distillation columns, and the mechanical aerators on the oxygen basins. Noise from the inlet compressors would be controlled by installation of noise deadening structures similar to those required by the air system. Noise from the mechanical aerators can be controlled by the specification of low noise motors and, if necessary, by acoustical housing. The switching valves on the cryogenic generator can be a major noise source if nothing is provided to control the noise generated. The vast majority of municipality-installed cryogenic oxygen generators have used reversing heat exchangers to remove impurities from the process air. These units switch

valving, resulting in a large noise emission, every 8-10 minutes. This noise can be mitigated by acoustical enclosure of the units.

Alternatively, the use of a molecular sieve type prepurifier, rather than the reversing heat exchangers, will produce significantly less noise overall. Both of the major oxygen vendors for wastewater treatment applications indicated that the molecular sieve application would be preferred in a generator of the size proposed for Deer Island, and that molecular sieves have historically been chosen for use in industrial oxygen generation applications. The molecular sieve units switch every 8-12 hours. Both the air and oxygen activated sludge systems can be designed to provide acceptable control of noise sources. The air activated sludge system would require fewer noise controls and thus would have a slight advantage over the oxygen activated sludge system in this regard.

Safety

Use of oxygen activated sludge requires the production and storage of high-purity oxygen. All of the required oxygen would be produced on-site; transportation of oxygen to the site from a remote source would not be required. The rate of gaseous oxygen production is based on the rate of oxygen demanded in the oxygen basins. Therefore, gaseous oxygen is utilized as it is produced, and is not stored. A percentage of the oxygen production capacity, usually 5-15% of the installed generation capacity, is used to produce liquid oxygen (LOX), which is stored on-site. LOX is used for peak oxygen demands above the capacity of the generation equipment, as a source of oxygen when generation capacity may be temporarily lost, and as an aid in starting up a cryogenic generator. Pure oxygen, either in the liquid or gaseous form, is not a combustible material. However, it will support rapid combustion of combustible materials. Operation of the system must include precautions related to elimination of ignitable sources. Many wastewater treatment facilities in the United States, including the existing Deer Island and Nut Island facilities, are accustomed to producing, storing, and using digester gas that must be handled in a similar fashion. Unlike oxygen, digester gas is both combustible and explosive in normal atmospheric air. There have been no reported oxygen-related accidents in wastewater treatment plants utilizing pure oxygen systems.

Hydrocarbons present in the incoming wastewater can be a potential hazard in the oxygen basins if the hydrocarbon concentration reaches the explosive limit. However, the oxygen basins are equipped with sensors to detect the presence of hydrocarbons in the oxygen atmosphere above the wastewater. These sensors are set at about 25% of the lower explosive limit. If the hydrocarbon concentration builds up to this level, alarms are sounded, the oxygen feed is shut-off, and the oxygen atmosphere in the aeration basins is purged and replaced with atmospheric air. The system cannot be restarted on oxygen until the situation is rectified. The frequency of hydrocarbon-related problems is a function of the wastewater being treated. However, operative management at existing oxygen activated sludge plants report that alarm and purging occur relatively infrequently, particularly if primary treatment is provided prior to the activated sludge process. There have been no reports of explosions occurring in oxygen aeration basins.

Air Emissions

All of the off-gases from the activated sludge process must be collected and treated for VOC removal. The collection and treatment of these gases is much more easily achieved in the oxygen activated sludge system. The small quantities of off-gases from an oxygen system create an ideal situation for the application of emission treatment and control. Peak and average air flows for the air system are 280,000 scfm and 120,000 scfm, respectively. Corresponding values for the oxygen system are 6,000 and 3,000 scfm. Air emissions standards, particularly for air toxics, are in a state of flux. As detection levels increase and emission limits become more stringent, control of air emissions will become more complex and costly. The oxygen activated sludge alternative, which generates only 2% of the vent air produced by air activated sludge, requires the least amount of control and offers significant advantages over the air system.

Recommendation

The recommended secondary component of the Deer Island Treatment Facilities consists of activated sludge with stacked, rectangular secondary clarifiers. Pure oxygen generated in a cryogenic unit is recommended as the means of providing oxygen, based on the ability of oxygen to efficiently treat highly variable loads without process upset, as well as its overall operability and lower air emission control requirements.

## 10.4.4 MODIFICATION TO THE ACTIVATED SLUDGE PROCESS - THE SELECTOR

The activated sludge process consists of two interdependent operations; aeration and clarification. During aeration, organic matter is removed from the wastewater and converted by the mixed liquor micro-organisms into water, carbon dioxide, and new micro-organisms. By this means, the colloidal and soluble matter which cannot be separated from the wastewater by gravity sedimentation is converted into suspended matter (micro-organisms) which can be separated by sedimentation. Following aeration, the mixed liquor micro-organisms (or mixed liquor suspended solids, MLSS) are separated from the liquid by gravity sedimentation in the secondary clarifiers. The separated solids are removed from the clarifiers as underflow and recycled to the aeration tanks for reuse in purifying incoming wastewaters. The overflow from the secondary clarifiers is the purified secondary effluent which, following disinfection, is discharged to the plant outfall.

The quality of the secondary effluent from the activated sludge process depends on the efficient separation of MLSS from the liquid in the secondary clarifiers. Poor separation can result in the loss of MLSS from the system and in a final effluent with high levels of suspended solids (TSS) and BOD. Excessive losses of MLSS can result in the failure of treatment in the aeration basin because the solids required for treatment cannot be recycled to the aeration tanks from the clarifiers.

The settling characteristics of activated sludge can be assessed by a test known as the Sludge Volume Index (SVI). The SVI is defined as the volume occupied by one gram of MLSS after 30 minutes of settling. A well settling activated sludge has a SVI of 100 ml/g or less. Poorly

settling sludges are commonly referred to as "bulking sludges" and have SVIs of < 150 ml/g. Bulking is commonly caused by an excessive growth of filamentous organisms in the activated sludge. These types of organisms interfere with settling by bridging between flocs or creating diffuse flocs.

Bulking sludges do not necessarily result in poor effluents. If the final clarifiers are capable of containing the bulking sludge, the final effluent may actually be of very high quality because the bulking sludge acts as a filter, entrapping fine solids that would otherwise escape to the plant effluent. Plants operating with a bulking sludge tend to be unstable and are subject to upset with variations in flow and/or organic load.

Bulking is a phenomenon that has been associated with the activated sludge process since its first application to wastewater treatment in the early part of this century. A survey of 50 United States plants in the 1940s indicated that two-thirds of the plants experienced bulking problems. A survey of 65 English plants in 1976 indicated that 42 percent of the plants commonly had SVIs in excess of 200. Similar surveys in Germany found that 45 percent of 315 activated sludge plants experienced various degrees of bulking. In the Netherlands, bulking sludges were found in 40-50 percent of all activated sludge plants treating domestic wastewaters. These surveys generally indicate that bulking is a common and worldwide problem in activated sludge plants.

In recent years there have been significant advances in understanding the causes of activated sludge bulking. Because there are many types of filaments in an activated sludge, there are indeed many causes of bulking. Identified causes of filamentous growth and the resulting development of a bulking sludge are nutrient deficiency (usually nitrogen and/or phosphorous), low dissolved oxygen (DO) concentration, high sulfide concentration and well-mixed continuously fed aeration basins.

Nutrient deficient bulking is a problem associated with some types of industrial wastes. For the other causes of bulking that are encountered in the treatment of domestic wastewater, the factor of overriding importance appears to be aeration basin configuration. In general, well settling activated sludges are produced by systems that allow a zone providing initial contact time between influent wastewater and return activated sludge, in which the wastewater soluble organic matter concentration is high, followed by a zone in which the wastewater soluble organic matter concentration is low. This high substrate/low substrate or feed-starve cycle can be achieved in several ways including batch feeding of wastewater, the use of "plug flow" or compartmentalized aeration basins fed with both wastewater and return activated sludge (RAS) at the head end, or the use of separate small initial basins in series, preceding the main aeration basin to which both wastewater and RAS are fed. The latter are known as selectors.

The use of a selector to control bulking is not a new concept. As early as 1949, Alex B. Davidson demonstrated the benefits of an anaerobic contact zone prior to aeration. Benefits from such a zone included the elimination of bulking and more efficient/reliable treatment. Heide and Pasveer recognized that aerobic activated sludge bacteria can take up organic matter in the absence of oxygen, and produce sludge with the superior settling characteristics associated with a selector. In the early 1970s, Chudoba demonstrated that bulking could be

controlled through the use of anoxic selector zones.

Three types of high F/M selector zones have been successfully applied to wastewater treatment: oxic zone (containing DO), an anoxic zone (containing nitrate but not DO), and an anaerobic zone (containing neither nitrate nor DO). To use the anoxic zone it is necessary to nitrify in the subsequent aeration phase in order to produce the nitrate required in the anoxic selector zone. The Deer Island activated sludge plant is not required to nitrify, and has been sized to avoid nitrification. Both the high F/M oxic and anaerobic selectors are protected under United States Patent Re. 32,429 issued on June 2, 1987 to Air Products and Chemicals, Inc. of Allentown, Penn. The original patent was No. 4,056,465 issued November 1, 1977.

While the mechanisms by which the various types of selectors function have not been precisely defined, the following is known:

1. Most types of filaments are favored over floc-forming organisms by low concentrations of soluble organic matter.

2. In a selector system the feed/starve cycle favors organisms with high soluble organic matter uptake rates and organisms with the ability to internally store the removed soluble organic matter.

3. In general, filamentous organisms are discouraged by the feed/starve cycle of the selector system because their soluble organic matter uptake rates and storage abilities are less than those of floc-forming organisms, and because the selector zone has a high soluble organic matter concentration.

4. For soluble organic matter to be taken up and stored in a selector zone, there must be available oxidizing power (an electron acceptor) to provide energy for the active transport and the formation of storage products.

   In oxic selectors this electron acceptor is DO; in anoxic selectors it is nitrate (reduced to nitrogen gas or deenitrified); and in anaerobic selectors it is the hydrolysis of internally stored polyphosphate to inorganic phosphate which is then released from the cells into the liquid.

5. The main aeration basin following the selector zone serves to regenerate the soluble organic matter uptake and storage capacity of the organisms by allowing for oxidation of material taken up and stored internally in the selector zone. For the anaerobic selector system, the main aeration basin also provides the environment for resynthesis of the intracellular polyphosphates required in the selector. The main aeration basin completes the selection process because it favors the growth of organisms containing stored organic material; there is very little soluble organic matter left following its uptake in the selector.

To date, the majority of full-scale selector applications have been oxic selectors associated

with nutrient removal systems using low organic loading rates and completely mixed aeration tanks. There has been a more recent trend toward the use of anaerobic selectors. A list of facilities operating or constructing selectors is presented in Table 10.4.4-1. The size, status and type of selector is indicated for each application.

The successful application of an oxic selector is dependent on providing the initial zone of high soluble organic loading with non-limiting oxygen conditions. If the oxygen uptake rate exceeds the oxygen transfer rate, dissolved oxygen limiting conditions will develop and the bulking control aspects of the selector will be destroyed because filamentous organisms caused by low DO conditions will develop and a bulking sludge may be produced.

Advantages claimed to be associated with the use of an anaerobic selector include stable operation under variable organic loading rates, a more uniform oxygen demand in the aeration zone, and a potential reduction in the overall oxygen utilization. Pilot-level comparisons between an anaerobic selector and high F/M oxic selectors have indicated that although both produce well settling sludges, the anaerobic selector produces sludges that have lower SVIs, and is more stable under highly variable organic loads. The settleability of the sludge from the anaerobic selector system was independent of the F/M of the aeration system. This feature makes this process particularly attractive for the Deer Island application where wide variations in load will occur. Peak oxygen uptake rates in the aeration zones following anaerobic selectors are reduced by up to 50% when compared to plug flow aeration basins. Total oxygen requirements in the aeration zones appear to be reduced, caused by an increase in transfer efficiency and/or the storage of unoxidized organics in the waste sludge. Operation of the anaerobic selector does not require the careful attention required in the case of the high F/M oxic selector to ensure that oxygen limiting conditions do not occur.

Operating facilities, pilot work, and controlled laboratory studies (Air Products, April 1987) using the anaerobic selector activated sludge system have indicated that nuisance odor conditions are not created in the anaerobic zone because sulfate reducing bacteria do not proliferate in the alternating anaerobic-aerobic environment.

The city and county of San Francisco Southeast Water Pollution Control Plant's pure oxygen activated sludge system (85 mgd) is currently testing an anaerobic selector in full scale. Half of the activated sludge system has been converted to an anaerobic selector system followed by oxygen activated sludge, while the other half of the plant continues to use a conventional oxygen activated sludge system. Both halves of the oxygen plant are operated at a low SRT (SRT 1.5-2 days) similar to the one proposed for Deer Island. Preliminary results from the testing program indicate that:

1. The anaerobic selector system is more stable in terms of SVI and effluent TSS.

2. The anaerobic selector appears to be effective in reducing (but not entirely eliminating) foam associated with the growth of Nocardia in the activated sludge system.

TABLE 10.4.4-1

TREATMENT PLANTS USING SELECTOR TECHNOLOGY

| Location | Plant Capacity | Status | Remarks |
|---|---|---|---|
| Largo, FL | 15 mgd | Operation | Nitrification/Denitrification |
| Lancaster, PA | 30 mgd | Operation | Pure Oxygen Aeration<br>Phosphorus Removal<br>Single Stage Nitrification |
| Pontiac, MI | 3 mgd | Operation | Phosphorus and Ammonia Control |
| Upper Occoquan, VA | 30 mgd | Operation | WPCF, March 1985 |
| Tri-City, OR | 8.5 mgd | Operation | Anoxic Selector |
| Rochester, NY | 15 mgd | Start-up | Retrofit, Non-nitrifying |
| Baltimore, MD | 70 mgd | Start-up | Phosphorus Removal, Non-nitrifying<br>Retrofit of coverred oxygen basins<br>Strong waste<br>HRT in anaerobic zone 1 hr<br>HRT in oxic zone 1.6 - 1.8 hr |
| Springettsbury, PA | 15 mgd | Start-up | |
| West Palm Beach, FL | 55 mgd | Construction | Non-nitrifying<br>Utilizes Fine Bubble Difused Air |
| Huron River Valley, MI | 12 mgd | Construction | Phosphorus Removal |
| Fayetteville, ARK | 11 mgd | Construction | |
| York, PA | 26 mgd | Design | |
| Titusville, FL | 3 mgd | Design | |

**TABLE 10.4.4-1**

**TREATMENT PLANTS USING SELECTOR TECHNOLOGY**
**(continued)**

| Location | Plant Capacity | Status | Remarks |
|---|---|---|---|
| Kerrville, TX | 3.5 mgd | Design | Nutrient Removal |
| Warminster, PA | 8 mgd | Design | |
| Newark, OH | 10 mgd | Design | |
| Genesee County, MI | 30 mgd | Design | |
| Louisville, KY | 15 mgd | | Expanding to 60 mgd |
| Detroit, MI | | | Retrofit to existing oxygen basins |

Impact on Clarifier Sizing

The clarifier sizing previously presented for the air and oxygen activated sludge systems was based on providing satisfactory operation and good effluent for systems with an SVI of up to 200 ml/g. Incorporation of a selector into the flow path would ensure a more reliable operation and a better settling sludge. This would apply equally to the air and oxygen activated sludge systems and does not affect the previous comparison between those systems. The selector is considered to be an optimization of both systems. Based on information available to date, the design of a system with an SVI of 150 ml/g and with a selector is probably more conservative than the use of an SVI of 200 ml/g without a selector. Incorporation of a selector would result in an overall reduction in capital costs with no increase in required land area and would assure a more stable operation. Air Products and Chemicals, Inc. has indicated that the license fee associated with the operation of the patented selector technology for the Deer Island application would be approximately five million dollars. Overall capital cost reductions are realized with the inclusion of the license fee.

Recommendation

The benefits associated with the selector warrant its inclusion in the Deer Island activated sludge system. Based on the benefits discussed above, including production of a well-settling activated sludge, stable operation under varying organic loading rates, potential reduction in oxygen requirements, the potential to reduce Nocardia foaming, and the lack of the need for operational control which, in the case of the high F/M oxic selector, ensures that oxygen limiting conditions are not present, it is recommended that an anaerobic selector be utilized.

The anaerobic selector zone should be sized to provide 20 minutes of contact time at average design flows. Selectors should be designed to allow variable contact time, since there is a considerable range in currently reported ratios of selector volume to aeration volume for optimum operation and results. Specific design methodology and criteria for the selectors should be based on pilot studies using the MWRA wastewaters. Design factors which should be determined through piloting include:

1. Selector volumes.

2. Oxygen requirements in the aeration tanks following the selectors. This should serve as the basis for final sizing of the cryogenic generation facilities and the oxygen dissolution equipment.

3. Design SVI for the secondary clarifiers.

4. Evaluation of the use of an anaerobic selector versus a high F/M oxic selector. Limiting dissolved oxygen concentrations would not be a problem in an oxygen aeration basin. The piloting should include optimization of the first stage of the oxygen activated sludge train so that it more adequately serves as a selector (for example, further compartmentalization so that it has a high initial F/M).

## 10.5 DISINFECTION

### 10.5.1 INTRODUCTION

This section evaluates disinfection alternatives for the Deer Island Plant.

The disinfection process is designed to reduce indicator bacteria present in the plant effluent to an acceptable level before it is released to the outfall. Based on the results of Section 8.0, three methods of disinfection were selected for evaluation: chlorination with sodium hypochlorite, ultraviolet irradiation, and ozonation. Chlorination with liquid chlorine was not included because a determination was made during the site selection process that the transport and storage of liquid chlorine at Deer Island was environmentally unacceptable.

### 10.5.2 EFFLUENT DISINFECTION STANDARDS AND REQUIREMENTS

The disinfection methods being evaluated must meet the effluent standards established in the discharge permit for the plant, the State's water quality criteria, and applicable design guidelines.

The discharge permit contains two criteria which are relevant to the disinfection process, the first to ensure biocidal efficiency and the second to ensure the absence of toxic by-products. The first criterion is that the most probable number (MPN) of fecal coliforms after disinfection must not exceed a count of 200 per 100 ml. The second criterion is that the effluent must pass a Whole Effluent Toxicity Test (WET test). In brief, this means that the disinfection process must not be lethal to fish, or other marine organisms. The WET test may result in a determination that for chlorinated effluents the chlorine residual present after disinfection causes an adverse impact. It is assumed that the outfall siting will ensure that a thirty-to-one ratio of dilution water is available. A chlorine residual of 7.5 ppb is acceptable in the receiving waters based on Gold Book water quality criteria. Therefore, the allowable residual in the effluent is 225 ppb or 0.225 mg/l. Standard process control by means of residual analysis is reliable down to about 0.5 mg/l with a limit of 0.1 mg/l, but it will be difficult to achieve this residual with process control alone. Alternatively, the addition of a dechlorinating chemical can be used to reduce residuals. For the options of ultraviolet and ozone these processes are not expected to produce residuals that might be unacceptable to the receiving water.

The Commonwealth of Massachusetts requires that for disinfection by chlorination, a minimum detention time of fifteen (15) minutes at peak flow be provided. In areas where the discharge is to shellfish beds, this requirement is raised to thirty (30) minutes. A fifteen-minute detention time has been utilized for the planning of disinfection tanks. No credit was taken at this stage for the detention time available in the outfall, which would greatly exceed 15 minutes at peak flow within the pipeline. If dechlorination is found not to be necessary, the outfall could serve to provide the required chlorination detention time. For both ultraviolet and ozone, the detention times are dependent on a review of the proposed system by the State.

Primary Effluent and Secondary Effluent Disinfection Requirements

Wastewater flow and effluent quality are the two variables that determine the sizing of the disinfection systems. The wastewater flow is directly associated with the prevailing groundwater conditions, which can be broken down into two categories throughout the year; high groundwater conditions and low groundwater conditions. High groundwater conditions exist from about February to May and low groundwater conditions are dominant for the remainder of the year. Each of these two conditions may further be broken down into periods of storm conditions and nonstorm conditions, along with flows for the maximum day (max. day) and the average maximum for any 30 day period for both high and low groundwater conditions (max. mo).

Initially, the discharge from the Deer Island Wastewater Treatment facility will be primary effluent, with secondary effluent coming a few years later. It is necessary to distinguish between the two cases, because when secondary treatment is added the quality of the effluent improves significantly. Specifically, since only chlorine can reduce the coliform count in the primary effluent to an acceptable level, only sodium hypochlorite options are available for the primary effluent period. For options involving chlorine this means that adding secondary treatment decreases the amount of chlorine needed for disinfection. For alternatives involving UV and ozone this means that disinfection by chlorine for the primary effluent will be necessary. For each circumstance, primary or secondary effluent, the concentration of suspended solids (SS) and biological oxygen demand (BOD) in milligrams per liter were as shown in Section 7.3. A range of chlorine dosage was determined based on the expected concentrations of BOD and SS present in both the primary and secondary effluents. The amount of chlorine needed in pounds and gallons for each of the various flow conditions can be calculated from the flow data and the required dosage. This information is presented in Table 10.5.2-1.

Other In-Plant Use of Disinfectants

In addition to the selection of a disinfection process for the plant's effluent it should be noted that it will be necessary to provide disinfection chemicals for other in-plant uses. There are three in-plant uses considered: non-potable water disinfection; bulking control; and odor control.

Non-potable process water, which will be drawn from the plant's secondary effluent for use in cleaning basins, chemical mixing, etc. is normally chlorinated to prevent slime growth and to protect the health of the workers. The amount of chlorine required for disinfection of non-potable water is 1,500 lb/day based on a non-potable water usage of 45 mgd and a dosage of 4 mg/l. This dose would be in addition to any disinfection prior to discharge.

Provisions for chlorinating the return activated sludge (RAS) at up to 15 mg/l to control bulking sludge may be required. This chlorine demand is large, but it is infrequent and seasonal. The amount of chlorine required for bulking control is estimated to range from 18,700 lb/day up to a maximum of 66,900/lb day.

Chlorine is also expected to be necessary for odor control systems. The total demand is not large but can be assumed to be a year-round demand with an increase in summer months. The

## TABLE 10.5.2-1

## CHLORINE REQUIREMENTS DURING PRIMARY TREATMENT AND SECONDARY TREATMENT PERIODS

Primary Plant Effluent

| | Low Groundwater Conditions | | | | High Groundwater Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Av. Day | Max. Day | Storm | Max. Mo. | Av. Day | Max. Day | Storm | Max. Mo. |
| Flow (MGD) | 374 | 511 | 1,065 | 486 | 714 | 966 | 1,223 | 800 |
| Dosage (mgCl/L) | 10 | 15 | 12 | 12 | 8 | 11 | 12 | 10 |
| Daily Cl Demand (1b) | 31,200 | 63,900 | 106,600 | 48,600 | 47,600 | 88,600 | 122,400 | 66,700 |

Secondary Plant Effluent

| | Low Groundwater Conditions | | | | High Groundwater Conditions | | | |
|---|---|---|---|---|---|---|---|---|
| | Av. Day | Max. Day | Storm | Max. Mo. | Av. Day | Max. Day | Storm | Max. Mo. |
| Flow (MGD) | 374 | 511 | 1,065 | 486 | 714 | 966 | 1,223 | 800 |
| Dosage (mgCl/L) | 3 | 6 | 8 | 4 | 3 | 6 | 8 | 4 |
| Daily Cl Demand (1b) | 9,400 | 25,600 | 71,000 | 16,200 | 17,900 | 48,300 | 81,600 | 26,700 |

total non-disinfection demand is highest during secondary treatment when chlorination demands are lower. Therefore, process disinfection demands dictate the size of required facilities.

Construction Scheduling

The evaluation of the disinfection unit process alternatives is also influenced by the location of the unit process onsite. The evaluation of layouts in Section 9.0 shows the disinfection process placed between the secondary clarifiers and the outfall tunnel. This location is separated from the primary clarifiers by the aeration basins. The construction of the primary facilities and the outfall tunnel are, at this time, expected to proceed simultaneously. To minimize conflicts associated with concurent construction of the effluent tunnel and the disinfection facilities in the same area, the option of using the aeration basin facilities for disinfection during the primary treatment phase was considered. For the air activated sludge operation this would require the construction of one battery. For the oxygen activated sludge option it would require the construction of two selector zone batteries. For the UV and ozone disinfection options this would eliminate the need to construct and then demolish a chlorine contact basin.

For comparison, the capital costs for all options reflect the expected cost of providing primary disinfection in one of the air activated aeration batteries for the period when the facility is operated as a primary treatment plant. If sodium hypochlorite is used for the disinfection of secondary effluent, then new chlorine contact channels would be constructed for this purpose.

### 10.5.3 SODIUM HYPOCHLORITE ALTERNATIVE

Two options were evaluated for disinfection with sodium hypochlorite (NaOCl): on-site production of NaOCl; and purchase of NaOCI and delivery by barge. Each of the options will feed sodium hypochlorite solution to a chlorine contact basin. The basin is the same for both options.

Sodium hypochlorite is a salt of hypochlorous acid, and is applied as a solution. Solutions of NaOCl vary in strength from less than 1% by weight to greater than 15% by weight. Solutions, once generated, decay with both time and exposure to sunlight, and the strength of solution diminishes rapidly if prepared at 15%.

Description and Configuration of Chlorine Contact Basins

The Deer Island Wastewater Treatment Facility will accept a flow of 1223 mgd during peak conditions. This peak flow is the controlling design factor for the NaOCl contact basins. Regulations require that, during peak flow, a minimum detention time of fifteen minutes be provided. Since it is possible that dechlorination will be necessary, a provision for dechlorination must be made. A dechlorination requirement eliminates the option of chlorination in the outfall and requires the use of contact basins.

To keep to a minimum, the area occupied by each section of the plant, the chlorine contact

basins have been laid out as narrow, deep channels rather than wide, shallow channels. The flow has been split among four basins, rather than travelling in a single large basin. This will allow for the draining of one basin for maintenance or cleaning while using the remaining basins for disinfection (with 3 of 4 basins in service there are 11 minutes of contact time at peak flow). Due to the site's area limitations, basins providing serpentine channels for the flow have been configured.

The channels have a depth of 24 ft and a width of 20 ft. Based on peak flow through the chosen area, a total overall basin length of 3555 ft is needed. To provide for flow splitting, four basins are used, each one 888 ft long, providing three passes of 296 feet. This meets the desired length-to-width ratio. The overall dimensions of the four basins, including wall thickness, are approximately 305 ft long and 280 ft wide, or 1.9 acres.

Flow into the basins is controlled by sluice gates, and the NaOCl is distributed through diffusers located at the head-end of the channels. The NaOCl is supplied by metering pumps that are paced by chlorine residual analyzers located at the tail-end of the channels. Flow out of the channels is controlled by a weir structure.

Purchased Sodium Hypochlorite

The purchased of sodium hypochlorite will involve transporting the disinfectant by barge to Deer Island. The sodium hypochlorite will be purchased from one of the area's chemical suppliers who must have access to a navigable waterway for efficient loading of the chemical.

Options for the trucking of NaOCl solution to the site were eliminated because of the large number of trucks that would be needed. The daily movement of 16 to 20 truckloads of NaOCl would occupy much of the roll-on/roll-off pier capacity and would be logistically infeasible.

The on-island berthing areas for the barged NaOCl require a connecting pipeline and a walkway for personnel to use when connecting and removing hoses for unloading the NaOCl. The proposed on-island pier facilities have been sized to accommodate bulk barges.

The barges could be owned and maintained either by the supplier or the MWRA. For simplicity the barge should have a pump on board for unloading the NaOCl. We have assumed that the barge has a capacity of approximately 400,000 gallons and dimensions of approximately 220 ft x 50 ft x 15 ft. Such barges can be readily obtained and retrofitted to transport NaOCl. The cost analysis assumes that the barges are owned and operated by the supplier and this is reflected in the chemical cost.

Transfer of the NaOCl from the barge to on-site storage tanks is estimated to take approximately three hours. It would be pumped from the pier to storage through two 12-in pipes. Such a layout allows for the isolation of either line for maintenance or repair purposes while still allowing unloading to continue. With both pipes in use, an even more efficient transfer of NaOCl could be expected. The pipes are fiberglass reinforced, approximately 3000 ft long, and joined by a common header at the storage tanks.

Alternatives were investigated for the best method of storing up to 750,000 gallons of NaOCl. A single 750,000 gallon tank does not provide back-up for periodic relining of the tank or for other types of maintenance. A second alternative is to provide eighteen (18) 40,000 gallon polyethylene tanks. These 12-ft-diameter tanks would be manufactured off-site, and are the largest that can be transported to the site by roll-on/roll-off barge. This option requires a header system composed of 18 connections constructed of chemical-resistant piping. A third alternative is the on-site construction of three 250,000 gallon capacity lined concrete tanks, each having an internal diameter of 40 ft and a height of 27 ft. This allows for the removal of one tank from service while still providing enough storage in the remaining two. This third alternative was selected in order to determine system costs.

The volume of 15% NaOCl solution that is required daily for the various operating conditions in both primary and secondary treatment is shown in Table 10.5.3-1. In 15% strength NaOCl solution, there is approximately one (1) pound of available chlorine in each gallon. The projected daily demands have been distributed over typical annual conditions for both the primary and secondary effluents. This has been converted to the required frequency of the arrival of 400,000 gallon bargeloads and is depicted in Figure 10.5.3-1. This figure shows that the volume of NaOCl required for high groundwater conditions and primary effluent phase governs the sizing of the delivery and storage systems. The projected daily demands have been integrated over an entire year for both the primary treatment phase and the secondary treatment phase. It is estimated that an annual total of 16,400,000 pounds of NaOCl will be required during the primary treatment phase, and that during the secondary phase an annual total of 6,200,000 pounds would be required. The expected cost of barged NaOCl is $0.35/gallon.

On-Site Generation of Sodium Hypochlorite

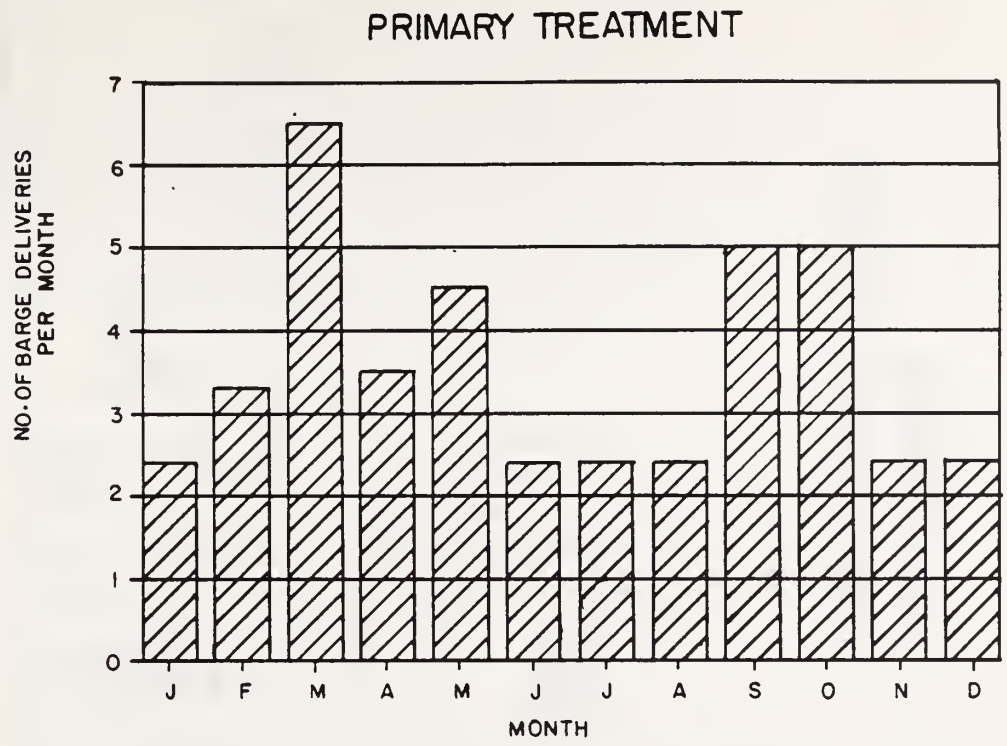
Systems for the on-site generation of NaOCl are available and have been included for evaluation. Figure 10.5.3-2 is a schematic of the on-site NaOCl generation system. An on-site system would use either brine or sea water as a feed solution to an electrolytic cell where the feed solution is converted to a weak NaOCl solution. By recycling the feed solution through the cells, the strength of the solution can be increased. Using sea water as a feed stock, it is expected that, with recycling, a 0.25% NaOCl solution can be achieved. This 0.25% solution would be fed directly to the chemical feed pumps and then to the application point in the disinfection basins.

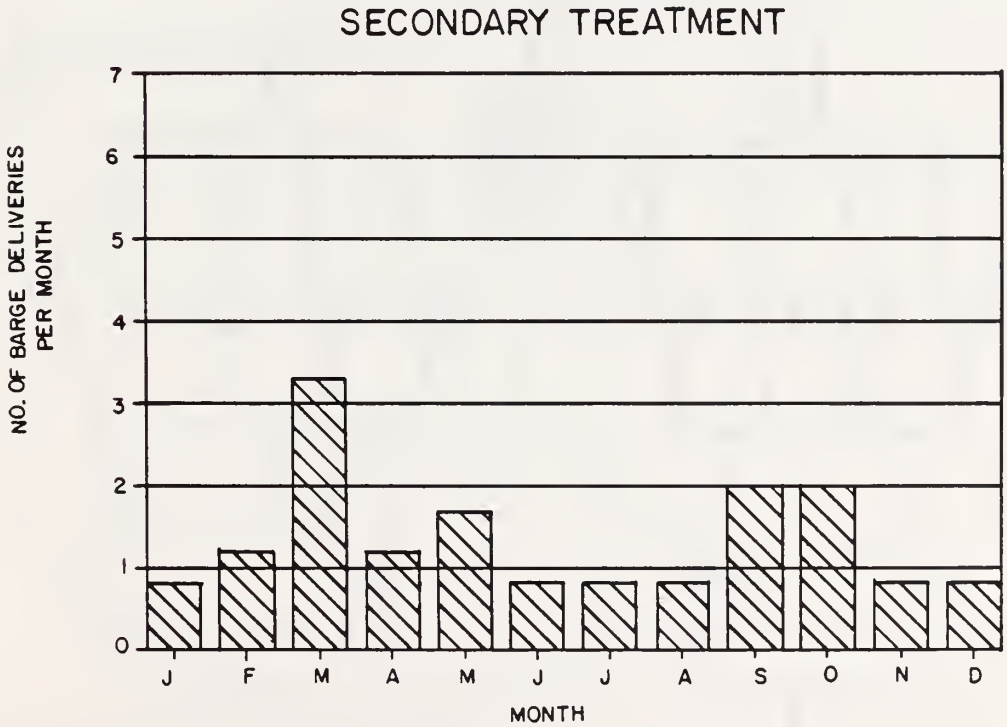
Because the on-site system produces a very low strength NaOCl solution, the volume of solution required is 60 times the volume required for purchased NaOCl. As shown earlier in Table 10.5.3-1 the peak requirement for disinfection is 122,400 pounds of chlorine per day which is equivalent to about 7.7 million gallons of 0.25% NaOCl solution per day. The option of sizing the system at less than the peak requirement and storing excess production during periods of low demand was examined and rejected because the volume of required storage would be excessive. For example, if the system were sized to produce 5.5 million gallons of solution per day, it is estimated that 40 million gallons of storage would be necessary to supply disinfectant during high groundwater maximum days with storm events.

**TABLE 10.5.3-1**

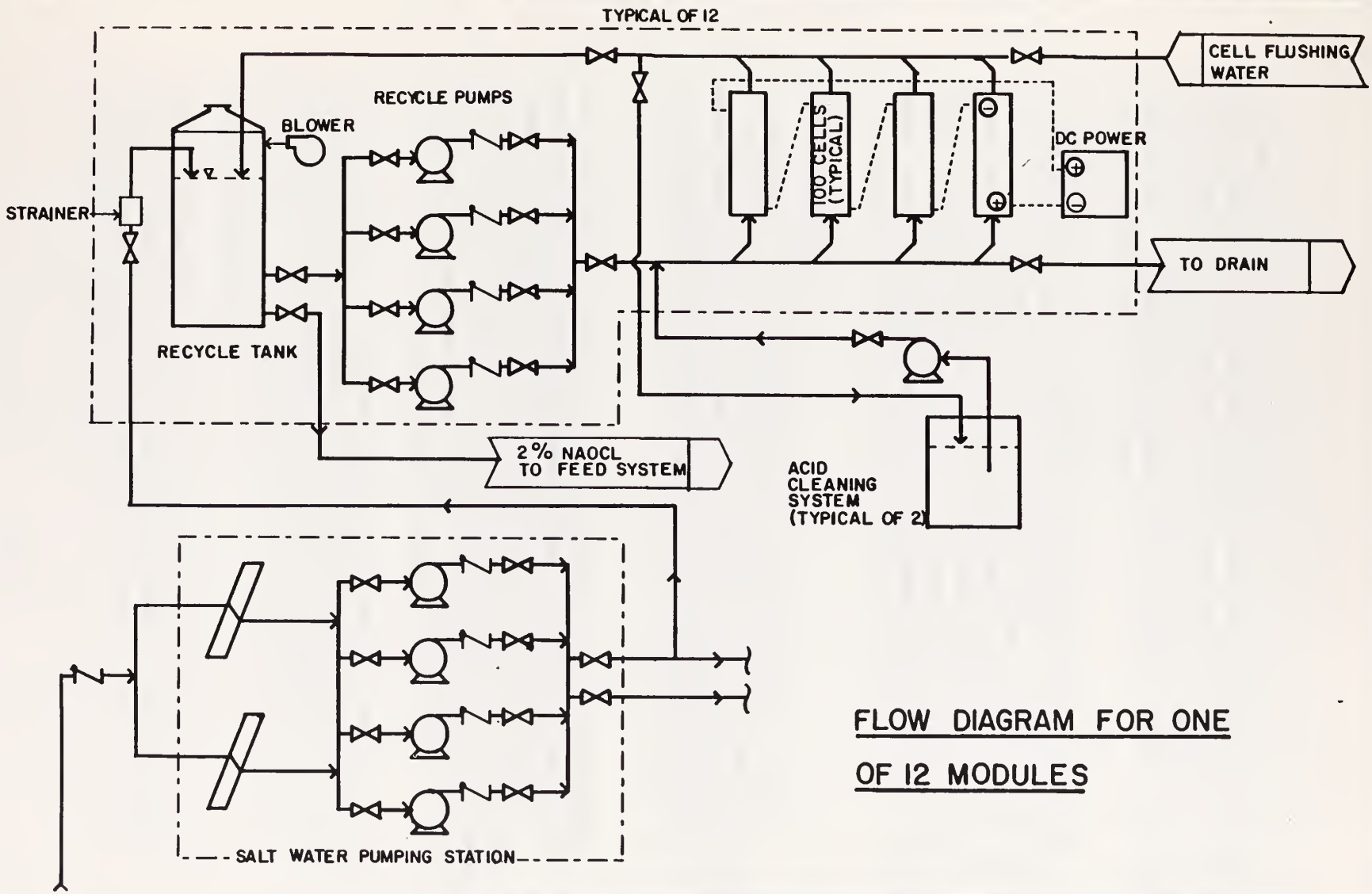
**DAILY DEMAND FOR PURCHASED SODIUM HYPOCHLORITE**

| | Low Groundwater | | | | High Groundwater | | | |
|---|---|---|---|---|---|---|---|---|
| | Av. Day | Max. Day | Storm | Max. Mo. | Av. Day | Max. Day | Storm | Max. Mo. |
| Flow (MGD) | 374 | 511 | 1,065 | 486 | 714 | 966 | 1,223 | 800 |
| PRIMARY EFFLUENT | | | | | | | | |
| Dosage Cl (mg/L) | 10 | 15 | 12 | 12 | 8 | 11 | 12 | 10 |
| lbs of Cl | 31,200 | 63,900 | 106,600 | 48,600 | 47,600 | 88,600 | 122,400 | 66,700 |
| Gallons of 15% Sodium Hypochlorite | 31,200 | 63,900 | 106,600 | 48,600 | 47,600 | 88,600 | 122,400 | 66,700 |
| SECONDARY PLANT EFFLUENT | | | | | | | | |
| Dosage Cl (mg/L) | 3 | 6 | 8 | 4 | 3 | 6 | 8 | 4 |
| lbs of Cl | 9,400 | 25,600 | 71,000 | 61,200 | 17,900 | 48,300 | 81,600 | 26,700 |
| Gallons of 15% Sodium Hypochlorite | 9,400 | 25,600 | 71,000 | 16,200 | 17,900 | 48,300 | 81,600 | 26,700 |




| | |
|---|---|
| **MASSACHUSETTS WATER RESOURCES AUTHORITY** | **FIGURE 10.5.3-1 FREQUENCY OF SODIUM HYPOCHLORITE BARGE DELIVERIES** |




FLOW DIAGRAM FOR ONE OF 12 MODULES

MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 10.5.3-2
DEER ISLAND
ON-SITE SODIUM HYPOCHLORITE GENERATION FACILITIES

The system considered has a total of 12 modules to provide the peak capacity volume of 122,400 pounds of chlorine per day. Each module contains recycle pumps, a recycle tank, a battery of 400 generating cells, and the associated electrical controls, piping and instrumentation. Each of the modules is fed seawater from a common pumping station and is connected to a common acid cleaning system. The generating cells require a routine maintenance procedure consisting of a nitric acid backwash to maintain cell efficiency.

The generating unit has a total of 4.800 cells, their power requirements varying with their age, the applied voltage, and the strength of the recycled solution. For costing, an optimum efficiency of 2.5 kwh/pound of chlorine produced, and an average value of 3.5 kwh/pound of chlorine produced were used. The peak electrical demand is approximately 15.3 Mw with a reduction to 12.7 Mw at optimum efficiency. The generating cells (or alternatively for some systems, the electrodes within them) are ultimately consumed by the processes. The cells are expected to be useful for approximately three years of operation. The on-site system would be housed in a structure with dimensions of about 36 ft by 85 ft by 30 ft high.

Dechlorination Systems

The dechlorination of chlorinated effluents may be required at this facility. Free and combined chlorine residuals can be effectively reduced by the application of approximately one pound of sulphur dioxide for every pound of chlorine residual. or the application of 1.5 pounds of sulphur bisulfite to a pound of chlorine residual. With both methods chemical reaction occurs rapidly, so that the chemical can be added directly into the effluent as it enters the outfall tunnel.

Process control for dechlorination can be provided by either the chlorine residual analyzer system or the sodium hypochlorite feed system. Reliance on the chlorine residual analyzer system minimizes the amount of dechlorination chemical used, but its dechlorinating effectiveness is totally dependent upon the accuracy of the analyzers (which require a high level of maintenance). Reliance on the sodium hypochlorite feed system results in a maximum use of dechlorinating chemicals. For this analysis it has been conservatively assumed that the dechlorination chemicals are paced from the sodium hypochlorite feed system.

For the sulphur dioxide option the chemical would be purchased as a compressed gas either in 1000 lb or 2000 lb (1 ton) cylinders. The chemical would be fed through a sulfonator to a water supply and then chemically metered into the effluent. A building would be required for the gas cylinders, sulfonators and metering equipment. Sulphur dioxide is a corrosive, irritant gas. Storage, transport and handling of the gaseous cyclinders is regulated due to its potentially hazardous nature.

Sodium bisulfite solutions are available at up to 38% strength with each gallon of solution containing approximately 3.7 pounds of available sodium bisulfite. This translates into a maximum requirement to receive, store and dispense one gallon of sodium bisulfite solution for every 2.4 gallons of NaOCl solution used.

Sodium bisulfite is manufactured by major chemical suppliers at locations in Delaware, South Carolina, and Louisiana. It is known that sodium bisulfite can be shipped by barge from the Delaware facility, but the availability of direct shipping from the other facilities is unknown.

Capital and Operation and Maintenance Costs of Sodium Hypochlorite Disinfection

The costs for the NaOCl disinfection systems and the dechlorination systems are tabulated in Tables 10.5.3-2 thru 10.5.3-4. The costs are presented as costs associated with disinfection of primary effluent and secondary effluents. The costs reflect the use of aeration basins for disinfection during the period of primary operation.

The total capital cost for the purchased NaOCl alternative including dechlorination with sulphur dioxide would be $21,200,000. The total capital cost for the on-site manufacture of NaOCl with dechlorination by sulphur dioxide would be $53,740,000. The selection of sodium bisulfite for dechlorination would have virtually no impact on the total capital cost.

The operation and maintenance cost for the purchased NaOCl alternative using sulphur dioxide as the dechlorinating chemical would be $9,500,000 during the years that only a primary plant would be operated, and would drop to $3,970,000 annually with the operation of the secondary process. This cost includes salaries and wages, the purchase of chemicals (which is the predominant cost), power, and equipment replacement. If sodium bisulfite were used as the dechlorination chemical the operational costs for primary and secondary treatment would both increase. The cost for disinfection in the primary treatment phase would become $15,410,000 and would drop to $6,210,000 for secondary disinfection.

For the on-site manufacture of NaOCl the annual cost of operation and maintenance includes salaries and wages, electricity, and routine equipment maintenance. The annual cost with sulphur dioxide as the dechlorinating chemical would be $7,090,000 for disinfection of a primary effluent and $3,510,000 for disinfection of a secondary effluent. If sodium bisulfite is used for dechlorination, then the costs rise to $13,000,000 for primary disinfection and to $5,750,000 for secondary effluents.

## 10.5.4 ULTRAVIOLET IRRADIATION ALTERNATIVE

Ultraviolet (UV) disinfection of potable and industrial water has been practiced for several years. However, it was not until recently that UV has been used for the disinfection of effluents from wastewater treatment plants, which have traditionally relied upon chlorination for this purpose.

Consideration is being given to UV for several reasons: protection of sensitive species in receiving waters from chlorinated compounds; ability to kill viruses at typical dosages; and ease of operation and maintenance of UV equipment.

TABLE 10.5.3-2

DISINFECTION AND DECHLORINATION
CAPITAL COSTS

| | Disinfection | | | | Dechlorination | |
|---|---|---|---|---|---|---|
| | Purchased NaOC1 Alternative | Manufacturer NaOC1 Alternative | Ultraviolet Irradiation Alternative | Ozone Alternative | Purchased Sulphur Dioxide Alternative | Purchased Sodium Bisulfite Alternative |
| **PRIMARY EFFLUENT** | | | | | | |
| Contact Basins | * | * | * | * | $ 810,000 | $ 810,000 |
| Diffusion Equipment | $ 930,000 | $ 930,000 | $ 930,000 | $ 930,000 | $ 930,000 | $ 930,000 |
| Storage Tanks | 780,000 | --- | 780,000 | 780,000 | --- | 780,000 |
| Equipment | --- | 21,910,000 | --- | --- | --- | --- |
| Building | --- | 2,980,000 | --- | --- | 1,200,000 | --- |
| **SECONDARY EFFLUENT** | | | | | | |
| Contact Basins | 10,120,000 | 10,120,000 | 2,760,000 | 10,120,000 | --- | --- |
| Diffusion Equipment | 930,000 | 930,000 | --- | --- | --- | --- |
| Equipment | --- | --- | 39,290,000 | 52,000,000 | --- | --- |
| Building | --- | --- | --- | 2,800,000 | --- | --- |
| SUBTOTAL | $12,760,000 | $36,870,000 | $43,760,000 | $66,630,000 | $2,940,000 | $2,520,000 |
| ENGINEERING & CONTINGENCIES | 4,470,000 | 12,900,000 | 15,310,000 | 23,320,000 | 1,030,000 | 880,000 |
| TOTAL | $17,230,000 | $49,770,000 | $59,070,000 | $89,950,000 | $3,970,000 | $3,400,000 |

*Aeration basins will be used for disinfection during primary phase.

TABLE 10.5.3-3

DISINFECTION AND DECHLORINATION
ANNUAL OPERATION AND MAINTENANCE COSTS

| | Disinfection | | | | Dechlorination | |
|---|---|---|---|---|---|---|
| | Purchased NaOC1 Alternative | Manufacturer NaOC1 Alternative | Ultraviolet Irradiation Alternative | $Ozone_3$ Alternative | Purchased Sulphur Dioxide Alternative | Purchased Sodium Bisulfite Alternative |
| **PRIMARY EFFLUENT*** | | | | | | |
| Salaries and Wages | | | | | | |
| Operation | $ 150,000 | $ 240,000 | $ 150,000 | $ 150,000 | $ 150,000 | $ 150,000 |
| Maintenance | 150,000 | 300,000 | 150,000 | 150,000 | 150,000 | 150,000 |
| Chemicals | 5,770,000 | 90,000 | 5,770,000 | 5,770,000 | 2,950,000 | 8,860,000 |
| Power | 90,000 | 3,120,000 | 90,000 | 90,000 | 90,000 | 90,000 |
| TOTAL PRIMARY EFFLUENT | $6,160,000 | $3,750,000 | $6,160,000 | $6,160,000 | $3,340,000 | $9,250,000 |
| **SECONDARY EFFLUENT** | | | | | | |
| Salaries and Wages | | | | | | |
| Operation | $ 150,000 | $ 240,000 | $ 150,000 | $ 240,000 | $ 150,000 | $ 150,000 |
| Maintenance | 150,000 | 300,000 | 100,000 | 300,000 | 150,000 | 150,000 |
| Chemicals | 2,180,000 | 30,000 | 30,000 | --- | 1,110,000 | 3,350,000 |
| Power | 30,000 | 1,120,000 | 1,110,000 | 2,400,000 | 30,000 | 30,000 |
| UV Lamps | --- | --- | 510,000 | --- | --- | --- |

TABLE 10.5.3-3

DISINFECTION AND DECHLORINATION
ANNUAL OPERATION AND MAINTENANCE COSTS
(continued)

| | Disinfection | | | | Dechlorination | |
|---|---|---|---|---|---|---|
| | Purchased NaOC1 Alternative | Manufacturer NaOC1 Alternative | Ultraviolet Irradiation Alternative | $Ozone_3$ Alternative | Purchased Sulphur Dioxide Alternative | Purchased Sodium Bisulfite Alternative |
| Cell Replacement | --- | 150,000 | --- | --- | --- | --- |
| Equipment Maintenance | 10,000 | 220,000 | 170,000 | 800,000 | 10,000 | 10,000 |
| TOTAL SECONDARY EFFLUENT | $2,520,000 | $2,060,000 | $2,070,000 | $3,740,000 | $1,450,000 | $3,690,000 |

TABLE 10.5.3-4

COMBINED COSTS
DISINFECTION AND DECHLORINATION

| | Purchased NaOC1 Alternative | Manufacturer NaOC1 Alternative | Ultraviolet Alternative | Ozone Alternative |
|---|---|---|---|---|
| CAPITAL COSTS | | | | |
| Disinfection of Primary Effluent | $17,230,000 | $49,770,000 | $59,070,000 | $89,950,000 |
| Disinfection of Secondary Effluent | 3,970,000 | 3,970,000 | 3,970,000 | 3,970,000 |
| TOTAL CAPITAL COST | $21,200,000 | $53,740,000 | $63,040,000 | $93,920,000 |
| Disinfection of Primary Effluent | $ 6,160,000 | $ 3,750,000 | $ 6,160,000 | $ 6,160,000 |
| Dechlorination of Primary Effluent | 3,340,000 | 3,340,000 | 3,340,000 | 3,340,000 |
| TOTAL PRIMARY | $ 9,500,000 | $ 7,090,000 | $ 9,500,000 | $ 9,500,000 |
| Disinfection of Secondary Effluent | 2,520,000 | 2,060,000 | 2,070,000 | 3,740,000 |
| Dechlorination of Secondary Effluent | 1,450,000 | 1,450,000 | --- | --- |
| TOTAL SECONDARY | $ 3,970,000 | $ 3,510,000 | $ 2,070,000 | $ 3,740,000 |

Ultraviolet disinfection is a genetically-based method of eliminating undesirable microorganisms. Microbial cells contain nucleic acids, DNA and RNA, which store genetic information. To live and reproduce, the cell must be able to faithfully replicate the biochemical information contained in these nucleic acids. However, when the cells are exposed to certain wavelengths of light, ideally from 255 nm to 260 nm, the DNA and RNA absorb the light energy, which damages or modifies the genetic information. This damage prevents any further replication and results in the death of that cell. Exposure of the organisms to the light is the key to the success of UV disinfection.

Several factors influence light transmissivity, which determines the effectiveness of UV. The intensity of the light to which the organisms are exposed is a function of the type of lamps used. Because the lamps may not come in direct contact with the water, they must be surrounded by transparent jackets which absorb some of the light. The jackets can become occluded from growths and must be routinely cleaned to maintain transmissivity. Since microorganisms in the wastewater must be exposed to a sufficient UV light intensity for a sufficient period of time to obtain the desired degree of disinfection, poor quality effluent hampers the disinfection effort. This means that UV should only be used with secondary plant effluent, which will not be produced at Deer Island initially.

Ultraviolet disinfection is relatively new in the area of wastewater treatment. Until recently it has been considered an innovative technology, but it has recently been designated by EPA Region I as a proven technology. UV is now recognized as a safe, reliable method of treating secondary effluents. The largest UV systems under construction are in the City of Quebec with sizes of 112 MGD and 102 MGD.

Ultraviolet Irradiation Contact Basin Design

The UV systems operate by immersion of the UV lamps in the wastewater stream. The channel depths are approximately five ft. The flow is divided into a series of short channels to provide 80 seconds of contact time. Each of the channels is 83 ft long by 18.7 ft wide. The channels would be fed from a common influent channel and would discharge to one of two effluent channels. Between channels a 10 ft space for the installation of the UV system controls would be provided. The contact basins would have overall dimensions of 280 ft by 206 ft, or about 1.3 acres. Flow into the basins would be controlled by sluice gates and flow out of the basins would be controlled by weirs.

Ultraviolet Irradiation Systems

The UV systems are available as modular units. A control panel would be necessary for every 16 units. Each of the modular units consists of 16 UV lamps. The total number of UV lamps needed for the facility is 51,200. The system would be monitored by a UV detection system which measures the strength of UV light emitted. Routine maintenance consists of changing bulbs and cleaning sheaths. The modular units are removed from the wastewater for the lamp changing. Sheath cleaning would consist of a periodic backwash with a mild nitric acid solution.

The power requirement at peak flow is 5.12 MW. The average power requirement is 2.28 MW. The lamps are expected to last approximately 13,000 hrs. Because the number of lamps has been selected to accommodate peak flow, not all of the lamps will be illuminated. Of the total of 51,200 lamps approximately 10,240 lamps per year would need to be replaced. The cost of each lamp is approximately $50.

Costs of Ultraviolet Irradiation

The capital cost of the UV system includes the cost of excavation and construction of the contact channels, the UV equipment and associated electrical interconnections, and the cost of providing NaOCl disinfection in the aeration basin and dechlorination during the primary treatment phase. The capital cost for the UV alternative is $63,040,000 as shown in Table 10.5.3-4.

The operation and maintenance costs for the UV alternative during the period of a primary treatment phase reflect the cost of disinfection by NaOCl and subsequent dechlorination by sulphur dioxide. The cost for the primary treatment phase is $9,500,000. This cost includes salaries and wages, chemical purchase (on-site generation is not feasible for a short interim period), and equipment maintenance costs. The annual operation and maintenance of a UV system for the secondary treatment phase is $2,070,000. This cost includes salaries and wages, power, lamp replacement and equipment maintenance. These costs are also tabulated in Table 10.5.3-4.

## 10.5.5 OZONE ALTERNATIVE

Ozone disinfection was evaluated under the condition that an oxygen activated sludge system at the Deer Island Facility would be installed and would provide a ''free'' source of oxygen feed to the ozone system. Ozone disinfection is generally inappropriate for wastewaters containing more than a 30 mg/l of BOD and SS, which means that ozonation is inappropriate for primary effluent. Therefore, chlorination would have to be employed during the primary treatment phase much as it is in the case of the UV option. To use ozone disinfection after the secondary facilities have been installed, contact basins would be constructed. For the expected effluent quality the size of the ozonation contact chambers would occupy more area than required for chlorination. Since the available area on the site is limited, ozone disinfection would have to be cost effective to justify allowing additional area for it. A minimum of 20 min contact time at peak flow would be required.

Ozone is a highly reactive and unstable form of oxygen, giving up its excess oxygen atom rapidly. Once generated, ozone must be used immediately. It cannot be stored. Ozone not consumed in disinfection reverts to its stable forms, elevating dissolved oxygen levels. There is no chemical residual. Ozone is produced by corona discharge in high voltage generators. The source of oxygen (carrier gas) would be from the high purity oxygen produced by the oxygen activated sludge treatment facilities described earlier. Ozone produced from dry air is more

expensive than that produced from pure oxygen and is not considered viable at this site. Therefore, it has not been evaluated.

Costs for Ozone

The capital costs of the ozone disinfection system are shown in Table 10.5.3-2. By far the most costly item is the ozone generation equipment. Operating and maintenance costs are shown in Table 10.5.3-3. Operating costs are based on the assumption that oxygen is available at no cost. The major portion of the operating cost is the power cost for the conversion of oxygen to ozone.

## 10.5.6 EVALUATION OF DISINFECTION ALTERNATIVES

The following is an environmental, technical, institutional, and cost evaluation of the disinfection alternatives. The evaluation also includes a discussion of the dechlorination alternatives and makes note of the need to provide different types of disinfection during the primary treatment and secondary treatment phases. An explanation of the rating for each of the evaluation criteria follows.

Environmental Criteria

Air Emission

No significant air emission sources are associated with any of the alternative disinfection processes. The on-site generation of NaOCl will produce hydrogen gas as a byproduct. Venting of the gas is not expected to require any controls.

Noise

No significant noise sources are associated with any of the alternative disinfection processes. Noise control for each of the alternatives is judged to be minimal.

Visual Impacts

The disinfection alternatives are expected to have modest visual impacts, with the exception of UV which is expected to have minimal impacts. For all alternatives the contact basin portion of the facilities is expected to have minimal impacts. For all alternatives the facilities are expected to be placed at the lowest elevation on the plant site which will generally reduce the visible profile of the facilities. For the UV alternative there is no adjacent support facility that would protrude above grade. For the purchased and on-site NaOCl alternatives as well as for the ozone alternatives, above grade storage or production facilities approximately 30 to 50 ft in height will be necessary.

Environmental Criteria

The alternative disinfection processes all require essentially the same land areas for their implementation (less than 4 acres). Consequently, in considering the potential impacts of these alternatives relative to land-based environmental criteria, all three alternatives have similar and minimal impacts:

- None of the alternatives affects historic or archaeological resources.

- None of the alternatives directly affects floodplains, wetlands, or barrier beaches.

- Effects on wildlife and endangered species are minimal for all alternatives.

The direct impacts on fish, shellfish, and biota will be considered in the evaluation of the outfall. Indirect effects on the marine environment include the potential for impacts resulting from an accidental spill during the transportation of purchased NaOCl, sulfur dioxide, or sodium bisulfite to Deer Island. The potential impact on marine resources resulting from an accidental spill during barge shipment could be significant, depending on the volume of the spill and the area and location affected by the spill.

Traffic

Traffic impacts for the disinfection process alternatives will result from both the construction and operation of the disinfection treatment facilities.

Construction of the NaOCl storage facility and contact tankage (purchase alternative) would require approximately 12 truck round trips per month to Deer Island, and an average of 16 daily round trips by construction workers over a period of 15 months. A similar impact for the construction of the NaOCl generation facility and associated disinfection facilities would require approximately 8 truck round trips per month and 22 daily worker round trips over a 15-month period. For the construction of the UV alternative, truck and worker transportation and associated impacts on traffic are similar to the other disinfection alternatives.

Construction traffic associated with the disinfection alternatives will be scheduled in to the barge/ferry transportation from the onshore transportation facilities.

Worker transportation options include ferrying workers to Deer Island from onshore transportation facilities and/or busing from satellite parking/transportation areas.
Offsite purchase of NaOCl involves transporting this chemical by barges with a capacity of about 400,000 gallons. Upon reaching Deer Island, the NaOCl would be pumped from the barges through pipes to lined storage tanks. Worst case delivery requirements have been estimated for peak dry- and wet-weather months for both primary and secondary treatment chlorination. The estimates assume six days of storm conditions, eight days of maximum disinfection use, and 17 days of average use per month.

For peak periods approximately 6.5 barge trips per month for primary treatment and 3.2 barge trips per month for secondary treatment would be needed to supply the chemical from the mainland.

Railroad delivery of NaOCl to the mainland terminal would reduce the trip requirements. Peak dry-weather month rail car deliveries per day would be 4 and 2 per day respectively, for primary and secondary treatment. Peak wet-weather month rail car deliveries would be 6 and 3 per day respectively. These NaOCl deliveries would require a transfer of material to truck and/or barge for on-island delivery.

Sodium hypochlorite could also be delivered by sea from a remote location. In this case, operations at a nearby mainland terminal would be necessary. The origin of the shipments and the vessel sizes used would require transfer to barges for final delivery to Deer Island.

For the on-site NaOCl generation alternative, a delivery of 12,500 gal per year of concentrated nitric acid would be required to maintain the generation equipment. The acid deliveries would occur every four to six months and each would require one truck trip.

For the UV alternative, no significant traffic shipments are required. Traffic would be limited to one truck load of nitric acid every four to six months, for cleaning purposes.

For operation of the disinfection facility, ten operators and mechanics will travel to the work site for the off-site purchase alternative. eighteen operators and mechanics are required for either the on site alternative or the ozone alternative, while 8 operators and mechanics are required for the UV alternative.

The transportation impacts described above are consistent with the construction and operation phase activities presented in MWRA's Final Facilities Plan report for On-Shore Water Transportation Facilities, April, 1987. Given the relative number of barge and/or roll-on/roll-off ferry/barge equivalent trips associated with off-island chemical shipment alternatives, the transportation impacts will be minimal for each of the disinfection alternatives.

Technical Criteria

Area Requirements

All of the disinfection alternatives require a defined area for the contact basins. For the options involving NaOCl a contact basin with dimensions of 305 ft by 280 ft by 24 ft deep is necessary. For disinfection by UV irradiation the contact basin area is smaller. It would have dimensions of 206 ft by 280 ft and would be 5 ft deep. The dechlorinating chemicals would be placed directly into the effluent outfall.

In addition to the contact basin area the disinfection alternatives require area for chemical supply facilities. The UV alternative would locate all of the appurtenant facilities, controllers and instrumentation within the contact basin area. For the purchased NaOCl option an area of 10,000 $ft^2$ for three storage tanks, metering pumps and instrumentation is required. The area for offloading facilities is considered to be already included within the pier facilities. For the on-site manufacturing of NaOCl a production building is required. This building would be approximately 31,000 $ft^2$ and would house the generating equipment, the metering pumps and instrumentation. For the dechlorination alternative a 7,000 $ft^2$ building would be required for the storage of sulfur dioxide. Alternatively, for the sodium bisulfite alternative an area of 10,000 $ft^2$ would be necessary for storage tanks.

Reliability/Flexibility

Disinfection with NaOCl and associated dechlorination is highly reliable and flexible. The supply system for barged delivery of NaOCl and dechlorination chemicals is subject to interruption due to weather conditions. However, sizing of the storage tanks compensates for this.

The onsite manufacture of NaOCl for the system is considered reliable. The lack of operating experience with a system of this size is offset by the modular design of the system. There is, however, a concern that the seawater intake system may be susceptible to biofouling, and this could negatively impact reliability.

UV is considered acceptable for the disinfection of secondary effluents. However, the system lacks proven history with regard to both primary and secondary effluents or poor quality secondary effluent. Furthermore, process control capabilities are limited by the lack of any direct, real-time measurement of process efficiency.

Ozone systems are reliable provided that the quality of the effluent is high. However, there is a risk that disinfection standards may not be met during periods of high storm flows. Since ozone cannot be stored, the ozone equipment must be sized with both sufficient redundancy to allow for maintenance and sufficient capacity for the worst case condition of effluent quality.

Constructibility

Construction of the contact basins for either the purchased NaOCl option or the on-site manufacturing of NaOCl presents a modest degree of difficulty because of the depth of the basins and their location at the lowest hydraulic point in the plant. It is expected that some groundwater could be encountered in the lower part of the basin excavation. The construction conditions for both the purchased storage tanks and the on-site generating building will present a modest degree of difficulty. The storage tanks will present difficulties, because of the specialty liner systems that will be necessary to protect against corrosion, and the generating building may present problems in construction because of the complexity of the equipment and the necessity for interaction of several of the building trades.

For the UV alternative, the impediments to construction will be minimal. The basins are relatively shallow, and the equipment consists of controllers and racks of light bulbs which are readily installed adjacent to and within the basin.

For the ozone alternative there is a modest degree of construction difficulty associated with the depth of the contact basins. Furthermore, because the ozone generating equipment is complex, the construction of the generating building will require the interaction of several of the building trades.

Personnel Safety

Purchased NaOCl, at 15% strength, should not be spilled in an unventilated building. As the proposed plan makes this an unlikely situation the purchased NaOCl alternative is rated normal for safety. Likewise, the manufactured NaOCl alternative is also considered normal, particularly since the solution is only 0.25%, which is very dilute.

The dechlorinating chemical, sulfur dioxide, presents risks associated with its handling and storage because it is a compressed gas. The gas is not explosive or flammable but it is considered a powerful irritant and in certain doses will produce suffocation. For this chemical, special safety precautions in handling and storage are required. It is expected that since sulfer dioxide, like chlorine, is a heavier-than-air gas, it would dissipate downwind and essentially at ground level, in a worst-case accident scenario. The $SO_2$ would be handled in 1-ton cylinders, in contrast to the present 16-ton chlorine tankers. For the dechlorinating chemical, sodium bisulfite at 38% strength, the safety precautions are similar to those required for NaOCl and are classified as normal.

The UV option is inherently safe and will only require that normal safety precautions be observed. There are no chemicals directly required for the process. Routine cleaning is expected to consist of an acid backwash, during which workers in the vicinity of UV systems should wear protective clothing and eyewear.

The ozone option requires that special safety precautions be observed. The contact basins and equipment work areas will need to be enclosed and constantly monitored to ensure that all ozone is contained.

Sodium hypochlorite, sulfur dioxide and ozone all present hazards to workers. Leak detection, high ventilation rates, and emergency eye washes and showers are required by code. Workers must be educated in the hazards of these chemicals. However, these chemicals are commonplace in wastewater treatment facilities, and, therefore, do not pose an unusual risk to workers.

Staffing Requirements

The disinfection alternatives all require approximately the same number of operators to monitor the efficiency of disinfection. Differences in staffing are related to maintenance

requirements. For the onsite generation of NaOCl and the manufacturing of ozone, additional personnel are required to operate and maintain those specific pieces of equipment. For the UV alternative, a staff position for a person to change the UV lamps is required.

Operational Complexity

Of the alternatives considered, UV requires the least attention. Operational factors are limited to power settings and keeping the lamp surfaces clean.

The NaOCl process is simple to operate, provided that frequent attention is given to recalibration of the analyzers and the instrumentation which pace the chemical feed systems. For the onsite generation of NaOCl the facility is modestly complex and will require a trained staff to properly operate.

The ozone systems are considered complex, but because of the high degree of instrumentation and process control provided with the systems, only a modest level of operational complexity results.

Power Needs

Purchased NaOCl and the dechlorination options of either sulfur dioxide or sodium bisulfite require minimal power for operation. Power is necessary to drive the chemical metering pumps and the associated process instrumentation. Power for off-loading of barges will be provided from the barges themselves.

The onsite manufacture of NaOCl will use significant amounts of power. During the primary treatment phase peak power requirements are 15.3 MW, and average power requirements are 4.6 MW. Requirements for secondary treatment will drop to a peak of 7.2 M and an average of 1.5 M.

The UV alternative also uses considerable power to operate the lamps. The UV system for secondary effluents will use 5.1 MW of power at peak conditions and will use 2.3 M of power under average conditions.

The ozone alternative is also power intensive. This alternative is also only applicable to secondary effluents. The power requirement assumes that oxygen as a feed source has been produced free and, therefore, power required at peak conditions is 9.4 M and at average conditions is 1.7 M.

Chemical Requirements for Operation

For disinfection by purchased 15% NaOCl, an average of 45,000 gpd during the primary period and 17,000 gpd during the secondary period will be required. Sodium hypochlorite is defined as a corrosive chemical by the Department of Transportation (DOT).

For disinfection by on-site NaOCl generation, an average production of 3,500,000 gpd during the primary treatment phase and 1,320,000 gpd during the secondary treatment phase will be required. Because this solution is dilute it is not considered hazardous. For routine cleaning, 12,500 gal of nitric acid will be required annually. This is a corrosive and hazardous substance according to DOT regulations and is handled in noncorrosive carboys.

For dechlorination by sulfur dioxide the average daily demand for the gas will be 45,000 lb/day during the primary period and 12,000 lb/day during the secondary period. The gas is a toxic and hazardous compound and must be transported and stored in accordance with DOT regulations for compressed non-flammable gases.

For dechlorination by sodium bisulfite, an average daily demand of 18,700 gpd during the primary treatment phase and an average of 7,000 gpd during the secondary treatment phase will be required. Sodium bisulfite, like sodium hypochloride, is a caustic, corrosive substance and must be transported and stored in specially lined vessels.

For disinfection by UV there are minimal chemical requirements: approximately 20,000 lb/year of nitric acid for cleaning would be required. Nitric acid is corrosive and must be stored and handled in accordance with DOT regulations. For disinfection by ozone there are no special chemical requirements external to the process.

Quantity and Quality of Residuals Generated

None of the disinfection or dechlorination processes under consideration are expected to produce any solid residuals. Disinfection by NaOCl will produce a chlorine residual that will require dechlorination.

Quantity and Quality of Spoils for Disposal and/or Relocation

The disinfection alternatives involving either sodium hypochlorite or ozone will require that a deep contact basin be constructed. The approximate volume of excavation is 82,000 $yd^3$.

For the UV option the contact basins are shallow. The approximate volume of excavation is 13,000 $yd^3$.

The amount of overburden excavation is expected to be approximately equal for all alternatives and is dependent upon the final selection of the plant hydraulic grade line.

The quality of excavation material is expected to be acceptable. All of these facilities are to be constructed in an area of the existing drumlin where acceptable soils are expected.

Ability to Provide Desired Quality of Effluent

There is no difference among the alternatives with regard to providing the desired quality of

secondary effluent. All alternatives are expected to disinfect a secondary effluent to acceptable coliform levels. For primary effluents only the NaOCl alternatives are acceptable.

Institutional Criteria

Timely Implementation

The relative difficulty expected in maintaining the installation schedule for the three disinfection alternatives are as follows: purchased NaOCl - modest; on-site generated NaOCl - difficult; UV - difficult; ozone - difficult.

The purchased NaOCl alternative, while less difficult to install than the other two alternatives, does, nonetheless, present some construction complexities. It will involve the installation of piping systems and controls capable of transporting the purchased chemical from barges at the pier docking facility to three large storage tanks, and metering the chemical from the tanks into the chlorination contact chamber. The tanks, while standard in materials and size, will nonetheless require custom, on-site erection. The need for a special liner, because of the relatively caustic nature of the NaOCl, will also add to the time and complexity of the tank construction.

Special berthing facilities will be required to allow the hook-up of large-diameter flexible pumping lines from the barges used to deliver the purchased chemicals.

The purchased NaOCl alternative will also require the acquisition of specially lined barges for the transport of the chemical. Each vessel will also be required to have pumping capacity on board to ensure that the NaOCl can be off-loaded. The ability to procure the purchased chemical from vendors who, as a condition of the service agreement, would provide their own barges, mitigates these concerns to a large degree and somewhat simplifies this aspect of the project.

Installation of the on-site NaOCl generation facility is considered to be more difficult than the purchased chemical alternative because of the need to substitute a rather complex and sophisticated chemical generating system for the barge off-loading system. This alternative will require the installation of 4800 generation "cells", the construction of a large high volume water intake structure, considerably more pumping and piping, a rather sophisticated instrumentation and controls package, special recycling and acid cleaning systems, and a hydrogen gas handling system.

The on-site generation systems will also require sizeable amounts of electrical energy and associated power transmission lines and back-up standby power supplies.

The rating of the installation of the UV disinfection system as "difficult" reflects many of the same factors encountered in the on-site NaOCl alternative. The technology, while not complex, requires considerable custom on-site installation, a sizeable amount of power and

additional electrical work, and a moderately sophisticated instrumentation package. Perhaps the most significant aspect of this alternative, though, is that it is not an acceptable technology for disinfecting primary effluent. Consequently, even if selected, it will still require the use of one of the other options during the period of secondary treatment construction.

All three alternatives should be rated "extensive" with respect to their potential impact on the permitting process. Receiving water quality standards dictate the degree of disinfection required. Meeting these standards is a significant and highly sensitive issue governing the selection of disinfection alternatives.

The alternatives involving the use of NaOCl may present special concerns, as the presence of chlorine residual may be detectable in the disinfected effluent.

Neither is the UV alternative an acceptable method of disinfecting primary effluent. UV is only effective during the period of exposure, and there is no way to apply an additional dose as the effluent flows through the outfall. Its use could require extensive monitoring/testing of the final, disinfected effluent.

External and Internal Coordination Requirements

The extent to which the proposed options pose significant coordination requirements is believed to be "extensive" for all three alternatives. This reflects the fact that all of the alternatives will require one form or another of "interim" disinfection facilities during the period of secondary treatment construction. Further, each will involve several vendors for the various components in order to provide barges for the purchased chemicals and the need to coordinate teams of skilled, onsite personnel for the installation of the various instrumentation packages.

Demand for Unique or Scarce Construction Resources

There are two major factors that tend to place all three alternatives in the "difficult" category. The first is the presence of competing construction projects in the Boston area. Demand for skilled labor for the third harbor tunnel and the central artery project are likely to make it extremely difficult to obtain adequate numbers of workers, especially in highly skilled job categories.

The fact that all three alternatives will require specialty items is also significant. Specialty resources, the ability of vendors to produce and deliver proprietary equipment, and the supply of skilled labor to fabricate, assemble and start up these units will most likely be stretched to their limits.

The purchased chemical alternative must rely on a limited number of vendors of specially lined barges. Similarly, both the on-site NaOCl generation alternatives and the UV irradiation alternatives rely on a limited number of qualified and experienced vendors. The limited local

experience with these two technologies, and the sheer size of the project which will require significant scale-up of these technologies, also suggest that there will be little capacity for absorbing schedule slippages and material delays.

Flexibility to Meet Future Changes

All three alternatives are ranked as "fair" with respect to their ability to accommodate future changes in treatment plant loadings and flows. The primary limitation is spatial: there is simply too little land available to provide for significant expansion of any of the alternatives. Second, all three alternatives will require significant modifications should there be any material changes in the volume or quality of the influent. Third, and finally, the degree of latitude for change is ultimately limited by the plant hydraulics, and, therefore, by the hydraulics of the disinfection units themselves.

Cost Criteria

Table 10.5.6-1 shows that on a present worth basis, disinfection with purchased NaOCl is the least costly alternative. This is true both with and without dechlorination, and regardless of the method of dechlorination selected. Among the dechlorination alternatives, the sulfur dioxide option is the least costly, on a present worth basis.

The present worth costs for disinfection and dechlorination options have been presented for the primary treatment period, the secondary treatment period and the total of the two periods. Because the disinfection process will use a portion of the aeration basins as a contact basin during the period when a primary effluent is being treated, the costs during that period reflect the capital costs associated with outfitting the aeration basins. Additionally, for the UV and the ozone alternatives the total present worth cost reflects the cost of disinfection by purchased NaOCl during the primary treatment period. For the total present worth costs of the alternatives, the present worth cost of dechlorination by sodium bisulfite has been added in.

The present worth analysis masks the impact of capital costs and the annual operation and maintenance expenses. The lowest present worth alternative, purchased NaOCl, has the lowest capital cost ($21.2 million) and the highest annual operational cost for the treatment of secondary effluent ($4.0 million with sulfur dioxide or $6.2 million if sodium bisulfide is used). The capital costs are low because there is little on-site equipment for the purchased alternative, and all costs are borne by the supplier and distributed over the period during which the chemical is supplied. Because the operational costs are not realized until a future date, they are discounted in the present worth analysis. For the UV alternative (the second lowest present worth cost), the capital costs are significant ($63.0 million), but the annual operation and maintenance cost is the lowest of all the alternatives ($2.07 million per year). The capital cost is realized early in the period of secondary treatment operation and is weighted heavier in the present worth analysis than the operations cost, which is realized later in the secondary operation and consequently is highly discounted.

## TABLE 10.5.6-1

## TOTAL COSTS FOR DISINFECTION AND DECHLORINATION CONSIDERING BOTH PRIMARY AND SECONDARY TREATMENT (millions of dollars)

| | DISINFECTION | | | |
|---|---|---|---|---|
| | PURCHASED SODIUM HYPOCHLORITE[1] | MANUFACTURED SODIUM HYPOCHLORITE[1] | ULTRAVIOLET IRRADIATION[2] | OZONE[2] |
| TOTAL COST AT COMPLETION OF SECONDARY | | | | |
| Present Worth Cost | 50.8 | 73.5 | 69.6 | 93.6 |
| Capital Cost | 21.2 | 53.7 | 63.0 | 93.9 |
| Annual Operation & Maintenance Cost[3] | 4.0 | 3.5 | 2.1 | 3.7 |



(1) Costs for NaOCl options assumes dechlorination with sulfur dioxide.

(2) Costs for UV and Ozone options assume purchased NaOCl and dechlorination with sulfur dioxide during primary treatment period.

(3) Costs for operation and maintenance of the secondary effluent include dechlorination where required.

As part of the present worth analysis, an evaluation of the sensitivity of the costs to changes in the cost of electricity was conducted. The purchased NaOCl alternative does not utilize any significant on-site power. It does, however, require power for its production at the place of manufacture. Each of the other three alternatives -- on-site generation of NaOCl, UV, and ozone -- uses significant amounts of on-site power. As an indication of the sensitivity of power costs, the on-site generation of NaOCl and the UV options were compared. The UV system uses less power annually than does the on-site generation system. Therefore, as the costs of power increase from the present $0.055/Kwh to $0.15 Kwh, the UV alternative, which is already less costly than the on-site generation of NaOCl, will become even less expensive.

Evaluation Matrix

Table 10.5.6-2 summarizes the evaluation of disinfection alternatives, and Table 10.5.6-3 summarizes dechlorination alternatives.

## 10.5.7 DISINFECTION FACILITIES

The options considered for disinfection of primary and secondary effluent are the use of sodium hypochlorite (either purchased or produced on-site), ultraviolet irradiation, and ozonation. For primary effluent only disinfection by sodium hypochlorite has been found to be effective and is recommended for the period before complete secondary treatment is provided.

For disinfection of secondary effluent, alternatives were compared using environmental, technical, institutional and cost criteria. Environmentally, all alternatives have similar impacts. The major difference is in the chlorine residual. Use of sodium hypochlorite would result in a chlorine residual in the treated effluent unless chemicals for dechlorination are added. Use of ultraviolet irradiation and ozonation do not result in a chemical residual in the effluent. Technically, sodium hypochlorite and ultraviolet irradiation rate high in reliability and flexibility. Ozonation does not have the same degree of reliability and flexibility because results are often inferior, in that a lower quality secondary effluent is produced. Such would be the case at Deer Island during storm events. Therefore, ozonation was rated as only "acceptable" for this category. Use of sodium hypochlorite produced on-site rather than purchased, and production of ozone, are more complex and require more operators than the purchase of sodium hypochlorite or the use of ultraviolet irradiation. Use of on-site produced sodium hypochlorite for disinfection of secondary effluent requires less power than ozonation or ultraviolet irradiation but much more power than purchased sodium hypochlorite and is preferred over other alternatives since the process is easier to implement. From a cost viewpoint, purchased sodium hypochlorite is also preferred. Present worth costs of sodium hypochlorite including costs for dechlorination are 30 to 45 percent less than other alternatives.

Primarily because of costs and long-term experience, sodium hypochlorite (purchased) was selected as the method of disinfection for both primary and secondary effluent. Ozonation is

## TABLE 10.5.6-2

## DISINFECTION UNIT PROCESS
## EVALUATION OF ALTERNATIVES

| Criteria | Purchased Sodium Hypochlorite | Manufactured Sodium Hypochlorite | Ultraviolet Irradiation | Ozone | Comments |
|---|---|---|---|---|---|
| ENVIRONMENTAL | | | | | |
| Air Emissions Control | Minimal | Minimal | Minimal | Minimal | Air Emissions Control of disinfection process not required. |
| Noise Control | Minimal | Minimal | Minimal | Minimal | |
| Visual Impacts | Minimal | Modest | Minimal | Modest | Buildings are required to house equipment for on-site sodium hypochlorite and ozone production. |
| Environmental Criteria | Minimal | Minimal | Minimal | Minimal | |
| Traffic Primary Effluent | 1 barge every 4-12 days | | | | Barges assumed to hold 400,000 Gallons. |
| Secondary Effluent | 1 barge every 10-38 days | -- | -- | -- | |
| TECHNICAL | | | | | |
| Area Criteria (Acres) | 2.2 Acres | 2.6 | 1.3 | 2.6 | Area for basins and buildings. |
| Reliability/Flexibility | High | Acceptable | Acceptable | Acceptable | Ozone and UV are not applicable to low quality secondary effluents. |

## TABLE 10.5.6-2

## DISINFECTION UNIT PROCESS EVALUATION OF ALTERNATIVES (Continued)

| Criteria | Purchased Sodium Hypochlorite | Manufactured Sodium Hypochlorite | Ultraviolet Irradiation | Ozone | Comments |
|---|---|---|---|---|---|
| Constructibility | Modest | Modest | Minimal | Modest | |
| Personnel Safety | Special | Special | Typical | Special | All but UV involve working with chemicals that will require safety procedures. |
| Staffing Requirements | 10 | 18 | 8 | 18 | Additional staff to operate and maintain production facilities. |
| Operational Complexity | Typical | Modest | Typical | Modest | Skilled staff required for production facilities. |
| Power Needs-Peak Primary: | Negligible | 15.3 MW | N/A | N/A | |
| Avg. Primary: | Negligible | 4.6 | N/A | N/A | |
| Peak Secondary: | Negligible | 7.2 | 5.1 | 9.4 | |
| Avg. Secondary: | Negligible | 1.5 | 2.3 | 1.7 | |
| Chemical Requirements for Operation - Primary: | 45,000 gal/day | 3,500,000 gal/day | N/A | N/A | Sodium hypochlorite options involve large quantities of liquid chemicals. |
| Secondary: | 17,000 gal/day | 1,320,000 gal/day | N/A | | |

**TABLE 10.5.6-2**

**DISINFECTION UNIT PROCESS EVALUATION OF ALTERNATIVES (Continued)**

| Criteria | | Purchased Sodium Hypochlorite | Manufactured Sodium Hypochlorite | Ultraviolet Irradiation | Ozone | Comments |
|---|---|---|---|---|---|---|
| Quantity of Residuals | | N/A | N/A | N/A | N/A | No solid residuals expected from the disinfection process (see Effluent Quality for Residuals in Solution). |
| Quality of Residuals | | N/A | N/A | N/A | N/A | |
| Quantity and Quality of Spoils | | 82,000 $yd^3$ | 82,000 $yd^3$ | 13,000 $yd^3$ | 82,000 $yd^3$ | UV basins are shallower than other basins. |
| Effluent Quality- | Primary: | 45,000 lb/d | 45,000 lb/d | 45,000 lb/d | 45,000 lb/d | Average pounds per day of free and available chlorine requiring dechlorination. |
| | Secondary: | 17,000 lb/d | 17,000 lb/d | N/A | N/A | |
| INSTITUTIONAL | | | | | | |
| Timely Implementation | | Modest | Difficult | Difficult | Difficult | |
| Permitting | | Extensive | Extensive | Extensive | Extensive | |
| External Coordination & Internal Coordination | | Extensive | Extensive | Extensive | Extensive | All options require an external coordinator with chemical manufacturer or equipment vendors. |

TABLE 10.5.6-2

DISINFECTION UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| Criteria | Purchased Sodium Hypochlorite | Manufactured Sodium Hypochlorite | Ultraviolet Irradiation | Ozone | Comments |
|---|---|---|---|---|---|
| Demand for Unique or Scarce Construction Resources | Difficult | Difficult | Difficult | Difficult | Other large projects in Boston will compete for resources. |
| Flexibility to Meet Future Changes | Fair | Fair | Fair | Fair | Change limited by plant hydraulics. |

TABLE 10.5.6-3

DECHLORINATION UNIT PROCESS
EVALUATION OF ALTERNATIVES

| Criteria | Purchased Sulfur Dioxide | Purchased Sodium Bisulfite | Comments |
|---|---|---|---|
| ENVIRONMENTAL | | | |
| Air Emissions Control | N/A | N/A | Process within outfall, no air emissions |
| Noise Control | Minimal | Minimal | No noise source associated with process. |
| Visual Impacts | Minimal | Minimal | Process is within outfall pipe. |
| Environmental Criteria | Modest | Modest | Spill may occur during transport. |
| TECHNICAL | | | |
| Area Criteria | 7,000 $ft^2$ | 10,000 $ft^2$ | Storage area for chemicals. |
| Reliability/Flexibility | High | High | |
| Constructibility | Modest | Modest | |
| Personnel Safety | Special | Modest | Chemical handling procedures must be followed. |
| Staffing Requirements | 5 | 5 | Would be additional duties for disinfection operators. |
| Operational Complexity | Modest | Typical | $SO_2$ requires a gas/water metering system. |

TABLE 10.5.6-3

DECHLORINATION UNIT PROCESS
EVALUATION OF ALTERNATIVES
(continued)

| Criteria | | Purchased Sulfur Dioxide | Purchased Sodium Bisulfite | Comments |
|---|---|---|---|---|
| Power Needs | | N/A | N/A | Negligible power needs. |
| Chemical Requirements for Operation | Primary:<br>Secondary: | 45,000 lb/day<br>17,000 lb/day | 18,700 gal/day<br>7,000 gal/day | Sufficient chemical to neutralize all "free" and "residual" chlorine. |
| Quantity of Residuals<br>Quality of Residuals | | N/A | N/A | |
| Quantity and Quality of Spoils | | N/A | N/A | No contact basin required. |
| Effluent Quality | | N/A | N/A | Process intended to maintain effluent quality. |
| INSTITUTIONAL | | | | |
| Timely Implementation | | Modest | Modest | |
| Permitting | | Moderate | Moderate | |
| External Coordination and Internal Coordination | | Extensive | Extensive | |
| Demand for Unique or Scarce Construction Resources | | Difficult | Difficult | |
| Flexibility to Meet Future Conditions | | Fair | Fair | |

not as reliable as the other methods. Between sodium hypochlorite (manufactured on-site) and ultraviolet irradiation, ultraviolet irradiation is preferred because it is slightly less costly and much simpler to operate compared to the production of sodium hypochlorite.

Two options for dechlorination were evaluated: sulfur dioxide and sodium bisulfide. The need for dechlorination of chlorinated effluent has not been established but may be required. A determination of the need for dechlorination is expected after pilot testing and associated whole effluent testing of the recommended process. Sulfur dioxide is a gas and is normally purchased in one-ton cylinders. Sulfur bisulfide is a solution similar to sodium hypochlorite. Environmentally and institutionally the alternatives are similar. Sulfur dioxide is a more complex system because it requires a gas/water metering system. It is a caustic, compressed gas and because of restricted site access/egress, concern about the consequences of an unregulated gas release (spill) make this alternative less acceptable from a safety perspective. (The volume of $SO_2$ under pressure is one ton; nevertheless, many similar issues as were raised for chlorine gas in 16-ton cylinders are applicable.) Capital costs of the two dechlorination methods are similar, but operating costs of sodium bisulfide are two to three times the cost of sulfur dioxide for secondary and primary effluent respectively. For safety reasons, sodium bisulfide was selected for dechlorination.

## 10.6 AIR EMISSIONS

### 10.6.1 INTRODUCTION

This section investigates emissions of odor-causing compounds and volatile organic compounds (VOCs) from the proposed Deer Island treatment plant and the Nut Island headworks, and the impacts of these emissions on ambient air quality. The remote headworks, which are currently undergoing renovation, are not included in this assessment. The impacts of emissions from the remote headworks should be reviewed after renovation is complete and accurate, comprehensive sampling of air streams is possible.

This section deals with emissions from the facilities proposed to treat the liquid wastewater streams at Nut and Deer Islands. Emissions from residuals handling facilities will be investigated under the Residuals Management Plan. Emissions from power production are covered in Appendix H and Section 11.4.2.

Details of the investigation on emissions from the liquid treatment process are presented in Appendix E.

### 10.6.2 REQUIREMENTS REGARDING ODORS

In Massachusetts, odors are regulated by local Boards of Health and the State Department of Health, by the Division of Air Pollution Control, and by the Division of Water Pollution Control. The Boards of Health and the Department of Health obtain their authority from Massachusetts General Law, Chapter 111, Section 122. The Division of Air Pollution Control is

empowered by the Massachusetts Air Pollution Control Regulations (310 CMR 7). The Division of Water Pollution Control relies on Massachusetts General Law, Chapter 83, Sections 6 and 7.

None of these laws and regulations sets numerical limits for odor. Rather, theses regulations state limits for odors only in general terms. For this study specific limits and odor thresholds have been used to assess the impact of odor-producing compounds.

The Secretary's Certificate on the Final Environmental Impact Report (FEIR) addresses the regulation of odors as a required mitigation measure. Briefly, the odor standard required is that there be no detectable odor when one part ambient air is diluted in one part of odor-free air.

### 10.6.3 REQUIREMENTS ON TOTAL AND INDIVIDUAL VOCs

Both the U.S. EPA and the Commonwealth of Massachusetts have adopted regulations for review and approval of new or modified sources of air pollutants before construction. Their concerns regarding emissions from the proposed Deer Island facility are set in regulations on two levels: increase in emissions of volatile organic compounds (VOCs); and the ambient impact of individual air pollutants. The concern over VOCs includes all non-methane hydrocarbons with a vapor pressure equal to or greater than 0.1 mm of mercury. These are considered to be precursors of ozone. The ambient impacts of air pollutants are compared with Allowable Ambient Levels (AALs) set by the Department of Environmental Quality Engineering.

#### Requirements for Emissions of VOCs

Section 301 CMR 7 of the Massachusetts Air Pollution Control Regulations requires that all new or modified sources of air pollutants apply the Best Available Control Technology (BACT) to control VOC discharges. BACT is not specifically defined, but requires a case-by-case assessment "taking into account energy, environmental, and economic impacts and other costs."

For new and modified sources emitting more than prescribed quantities of VOCs after BACT, the facility is required to install and operate equipment to meet Lowest Achievable Emission Rate (LAER). LAER is the rate of emission that reflects the most-stringent emission limitations in the State Implementation Plan of any state, or control that has been achieved in practice by comparable sources.

A modification to an existing major source -- one currently emitting more than 100 tons per year of VOCs -- must incorporate equipment capable of meeting LAER to control VOC discharges if it is determined that, after the application of BACT, the proposed increase above the baseline condition would be greater than or equal to 40 tons/yr. Because the Boston area does not meet National Ambient Air Quality Standards (NAAQS) for ozone, this emission increase above the baseline after LAER control would also have to be offset by obtaining an equal reduction, plus an additional ten percent reduction, in the level of VOC emissions from an existing source so

as to demonstrate reasonable progress toward attainment of the standards for ozone. For this project, the Massachusetts Department of Environmental Quality Engineering (DEQE) has selected the baseline condition to represent conditions in existence or permitted as of December 31, 1986.

Requirements on Emissions of Individual Constituents

Massachusetts reviews the impact of toxic air pollutants using the procedure described in a report entitled The Chemical Health Effects Assessment Methodology and the Method to Derive Allowable Ambient Levels (DEQE, 1985 and 1987). Air toxic review therefore entails determining that the emission rates of air pollutants from the entire proposed facility do not cause incremental air pollutant concentrations that exceed established AALs.

The AALs developed by DEQE represent the maximum allowable 24-hour incremental ambient impacts that are allowed to be produced by emission of certain pollutants from the proposed facilities. Consistent with air toxic review in other areas of the country, compliance with the AALs in Massachusetts requires that the calculated ambient increase in concentration be less than the AAL at all locations of public access beyond the fence line of the facility.

AALs for all noncarcinogenic constituents were obtained from DEQE's list of AALs, or were calculated and submitted to DEQE for review and concurrence. The AALs for the carcinogenic constituents were calculated on an annual basis using data generated by EPA's Carcinogen Assessment Group (CAG) or Health Effects Assessment (HEA) group. The calculation involved transforming the published cancer potency factor, given in terms of the inverse of milligrams of intake per kilogram of body weight per day [(mg/kg-day)-1], into an allowable 24-h ambient concentration presented in terms of micrograms per cubic meter ($5g/m^3$). The transformation from cancer potency (which assumes constant exposure over an average lifetime of 70 years) to an annual AAL required the establishment of an allowable risk level (1 in 100,000 per DEQE), a daily inhalation rate (20 $m^3$/day per CAG), and an average human body weight (70 kg per HEA and CAG). The annual concentration was then transformed to a 24-h concentration based on multiplying by a 24-h conversion factor of 3.35. This factor is based on meteorological data for Logan Airport, and accounts for the amount of time that the wind blows in the same direction for a 24-hour period.

Several of the compounds might also produce an odor. DEQE requires that the ambient impact of such compounds be kept below the level where a nuisance occurs. In this case, the odor threshold was used in assessing the impact on ambient levels.

Finally, rules for Prevention of Significant Deterioration (PSD) require BACT review for a variety of "non-criteria" air pollutants released in significant amounts. Although the project is not subject to PSD review for VOCs, other air pollutants will trigger the PSD review requirements for these non-criteria pollutants. With respect to the wastewater treatment facilities, the only other pollutants requiring specific PSD review are the compounds included in the Total Reduced Sulfur (TRS) category. These include hydrogen sulfide, mercaptans, and

carbon disulfide. The significant emission rate (the rate requiring PSD review) for TRS is 10 tons per year.

### 10.6.4 QUANTITIES OF COMPOUNDS

Sources of Data

The sampling studies conducted in the Fall of 1986 and the Spring of 1987 are described in Section 6.1. The sampling program specifically analysed more than 150 compounds from EPA's Priority Pollutant List (PPL) and Hazardous Substances List (HSL), and supplemented those compounds by searches of mass spectrographs to identify and quantify other organic compounds. For simplicity, all of these are referred to as PPL/HSL compounds.

For analysis of air emissions, only the detected pollutants having a vapor pressure higher than 0.1 mm Hg, as defined in Massachusetts regulations, were included. Most of these were part of the "volatile" fractions of the Priority Pollutant List, but some were also measured under the acid and base/neutral analyses.

The procedure for statistically analyzing the results and for projecting loads and flows to the design year are described in Section 6.2.

Pollutants for which more information is needed

The PPL/HSL VOCs identified in the sampling program are not the only organics that can be emitted from wastewater during wastewater treatment. Others include volatiles already in the wastewater and volatiles produced during wastewater treatment.

The other VOCs already in the wastewater include VOCs that are not in the PPL or HSL groups, and VOCs present individually in concentrations below detection limits. To estimate the total VOCs emitted, total ion chromatograms were examined. The concept was that the total area of a total ion chromatogram should represent the PPL/HSL VOCs and all other VOCs in the wastewater. Unfortunately, the total area measurements were not a valid estimation of the total concentration, for a number of reasons. The primary reason for the procedure's failure was that many were not chromatographable under the conditions utilized for the PPL/HSL analysis. Basically, the two determinations proved to be incompatible. Also, the sample's wastewater matrix adversely affected the analytical results.

Because this approach failed to suggest the concentration of the total VOCs, the results of air sampling at three headworks were examined. Using the results of these analyses of air samples, it is estimated that for every lb of VOC measured by testing for individual compounds in air samples at the headworks, there might actually be a total of 20 to 50 lb of total VOCs. In the work for this project, data have been multiplied on the sum of individual components by 20 to 50 to estimate total VOCs. (This is somewhat confirmed by work at three wastewater plants in Cincinatti, where gas chromatographic analysis for 24 specific compounds on air samples from wet-well and bar-screen areas accounted for less than 10 percent of total VOCs found.)

In addition, volatile compounds can also be produced in biological treatment. These compounds can include volatile intermediate products or by-products such as alcohols, aldehydes, and terpenes. However, no information reporting the volatile compounds produced and emitted during wastewater treatment by activated sludge is available. Consequently, for estimates of total emissions, no allowance for VOCs produced during treatment were included. Thus the estimates of emissions from activated sludge treatment might be somewhat low and measurements on the potential for formation and emission of VOCs during biological treatment need to be obtained prior to final design.

### 10.6.5 EMISSION ESTIMATION PROCEDURES AND RESULTS

#### Scenarios Evaluated for Emission Calculations

Emissions were estimated for eight combinations of activated sludge processes and wastewater flow/pollutant load conditions. The eight combinations consisted of two process variations and four conditions of flow and load. Process conditions included a diffused air system in the activated sludge process, and pure oxygen feed to the activated sludge process.

The four conditions of flow and load represented the following: average wastewater flow with average dry-weather constituent mass loadings; minimum wastewater flow with maximum dry-weather constituent mass loadings; maximum dry-weather flow with maximum constituent mass loadings; and maximum wastewater flow, plus stormwater flow with maximum constituent mass loadings, plus the storm constituent loadings. In general, these conditions were anticipated to produce the greatest short-term emission rate for subsequent dispersion modeling.

#### Description of Removal Mechanisms

Several mechanisms contribute to a loss of volatile compounds from wastewater treatment systems. The two major removal mechanisms -- volatilization and biodegradation -- were considered in this assessment. Volatilization is the only removal mechanism that leads to an atmospheric emission, and occurs when a molecule of a substance dissolved in the wastewater escapes from the liquid phase to an adjacent gas phase. The adjacent gas phase can be an air bubble within the liquid or in the atmosphere above the liquid. As such, emissions due to volatilization can occur from quiescent liquids found in holding tanks or clarifiers, and from turbulent liquids found at weir overflows and in aeration tanks. Biodegradation occurs when microbes decompose organic compounds for use in their metabolic processes. The rate of this decomposition varies by compound, depending on the compound's structure and the needs of the microbe for the compound. At a wastewater treatment plant, biodegradation occurs in the aeration tanks where it competes with volatilization as a removal mechanism.

In addition to the two major removal mechanisms considered, other mechanisms can also exist that would tend to lower the amount of volatile material released from the liquid process of a treatment plant. These mechanisms include chemical oxidation and sludge partitioning. Chemical oxidation involves the degradation of compounds by oxygen, chlorine, or organic acids.

Sludge partitioning involves the movement of a given compound from the liquid phase to the solid phase. These mechanisms were not considered in this assessment for three reasons: they are less important than those mechanisms considered; omission of these mechanisms will maximize the calculated emission rates for all compounds considered; and the procedures and data required to accurately determine the extent of removal by these mechanisms are not available.

The details about the formulas used for estimating emissions are provided in Appendix E.

Data for Constituents of Interest

Several types of data are needed to perform the required emissions calculations. The general classes of data can fall into either a constituent category or a source category. Within each of these categories, the data can either remain constant between scenarios (e.g., constituent vapor pressure or treatment system dimensions) or vary between scenarios (e.g., constituent concentration or wastewater flow rate). To estimate emissions, properties of the constituents of interest and information relevant to the system design and operating parameters were complied from the best available information sources.

To facilitate the multitude of emission calculations, each constituent was assigned to a surrogate class. Some of the data used for calculations were derived from surrogate properties, while other data were input directly by constituent. Direct input was used for concentrations, biodegration rate, and removal rate in the air pollution control system; Data pertaining to Henry's Law and diffusivity were derived from the surrogate properties. With the exception of influent concentrations, data for the constituents remained constant between scenarios. The data, however, were adjusted to account for influencing parameters such as temperature and oxygen transfer rates.

The data were compiled from a variety of sources. Information on the actual Henry's Law constants were obtained from the US EPA's documentation of their emission/dispersion model ( US EPA,1987). These data were used to establish the surrogate groups and the Henry's Law constants for each surrogate. Actual diffusivities for each constituent were likewise obtained from EPA documentation and used to define the diffusivity value for each surrogate group.

The biodegradation rates were based on reported rate constants from a variety of sources. There is generally poor agreement within the literature on biological conversion rates, and much of the data published are based on high concentrations of single constituent wastes. As a result, some judgment had to be applied in selecting of the biodegradation rates. Those constituents for which no data could be found or derived were conservatively assumed to have a biodegradation rate equal to zero.

Sources of Emissions at Deer Island

Major wastewater treatment facilities at Deer Island will include:

- o The North Main Pumping Station
- o Winthrop Terminal
- o South System Pumping Station
- o North System Grit Facilities
- o Grit Classifiers
- o Primary Effluent Screening Facilities
- o Primary Influent Channels
- o Primary Splitter Box
- o Aerated Channels
- o Primary Clarifiers
- o Secondary Splitter Box
- o Anaerobic Selector Basin
- o Aeration Basins
- o Secondary Influent Channel
- o Secondary Clarifiers
- o Secondary Sludge Pumping Station
- o Disinfection Basins
- o Outfall

Sources of odor-causing compounds and VOCs are the facilities where interfaces between wastewater and air are produced. These interfaces are produced at tank surfaces, channels, weirs, and aeration tanks. Emissions are not released, of course, from pumps and pipelines.

The emissions facilities were divided into three groups. One group includes facilities that have the potential to emit VOCs in amounts sufficient to impact on ambient air levels. Emissions from this group were calculated and the results were used in air-quality modeling to determine the impact on ambient air quality. These facilities include:

- o Grit Removal Facilities
- o Primary Splitter Box
- o Primary Clarifiers
- o Secondary Splitter Box
- o Anaerobic Selector Basin
- o Aeration Basins
- o Secondary Clarifiers
- o Disinfection Basins

The second group includes facilities that emit odors and VOCs in quantities high enough to require ventilation for decreasing the levels in the work environment. Air vented from these facilities would be collected and treated before exhaust, but the small amount of VOCs released after treatment would not be included in air-quality modeling. These facilities include:

- o Winthrop Terminal system
- o Vent Shafts from North System Tunnels
- o Wet Wells from South System Pumping Station
- o Primary Screening Facilities
- o Grit Classifiers.
- o Primary Influent Channel
- o Secondary Influent Channel
- o Secondary Sludge Pumping Station

The third group includes only the outfall vent, which will have little potential for release of odor-causing compounds and VOCs. Thus, exhaust would not require treatment before release to the atmosphere.

Results of Emission Calculations

Emissions were calculated for existing and proposed facilities at Nut Island and alternative Deer Island treatment trains consisting of air or oxygen activated sludge. Emissions from the existing treatment systems on Deer and Nut Islands were also calculated. The output generated by the computer program used provided an annual emission total for each constituent, by treatment unit, as well as the individual maximum emission rate for each constituent across the entire system.

The existing facilities on Deer Island were estimated to emit a total of about 40 tons/yr of PPL/HSL constituents; existing Nut Island facilities were estimated to emit about 7 tons/yr. (See Table 10.6.5-1.) As described in Section 10.6.4, the emissions of total VOCs could be some 20 to 50 times these values. Thus, at the baseline condition, Deer Island could release from about 800 to 2000 tons per year of VOCs, and Nut Island could release from 140 to 350 tons per year of VOCs. Because the facilities each emit more than 100 tons of VOCs per year, both the Deer Island and Nut Island plants would be considered to be major sources.
The proposed treatment facility at Deer Island will include covers to prevent uncontrolled release of air pollutants. The covers will be installed on all portions of the facility between and including the centrifugal grit chambers and the aeration tank effluent weirs. The emissions from each of these treatment systems will be collected and delivered to an odor/VOC control system before discharge to the atmosphere. Several independent systems will be operated for control of offgas streams from various treatment units.

For the purpose of providing a conservative estimate, a control efficiency of 85 percent through the emission control system, has been assumed for all constituents except the reduced sulfur species; 95 percent control has been assumed for these constituents. Based on these removal efficiencies, the annual controlled emission rate is 15.3 tons/yr of PPL/HSL constituents for the air system and 14.7 tons/yr for the oxygen system. Table 10.6.5-1

TABLE 10.6.5-1

COMPARISON OF ANNUAL CONTROLLED CONSTITUENT EMISSION ESTIMATES FOR THE EXISTING AND FUTURE TREATMENT SYSTEMS ON DEER AND NUT ISLANDS (tons/yr)

| | Deer Island | | | Nut Island | |
|---|---|---|---|---|---|
| | Existing | Future | | Existing | Future |
| Constituent | | oxygen | air | | |
| Benzene | 0.64 | 0.20 | 0.20 | 0.09 | 0.01 |
| Chloroform | 0.91 | 0.39 | 0.41 | 0.13 | 0.02 |
| Ethylbenzene | 1.38 | 0.53 | 0.50 | 0.25 | 0.03 |
| Methylene chloride | 5.16 | 1.58 | 1.64 | 0.80 | 0.13 |
| Tetrachloroethene | 2.26 | 0.70 | 0.73 | 0.37 | 0.06 |
| Toluene | 3.10 | 0.92 | 0.90 | 0.30 | 0.05 |
| Trans-dichloroethene (1,2) | 1.37 | 0.41 | 0.44 | 0.23 | 0.03 |
| 1,1,1-Trichloroethane | 2.15 | 0.92 | 1.11 | 0.27 | 0.04 |
| Trichloroethene | 1.68 | 0.80 | 0.77 | 0.26 | 0.04 |
| Trichlorofluoromethane | 1.97 | 0.55 | 0.61 | 0.30 | 0.05 |
| Styrene | 1.47 | 0.64 | 0.71 | 0.23 | 0.04 |
| Acetone | 0.43 | 0.13 | 0.09 | 0.10 | 0.01 |
| 2-Butanone | 0.00 | 0.02 | 0.02 | 0.08 | 0.00 |
| Total xylenes | 4.65 | 1.29 | 1.30 | 0.46 | 0.08 |
| 1,1,2,2-Tetrachloroethane | 0.14 | 0.13 | 0.18 | 0.08 | 0.00 |
| Methyl mercaptan | 2.84 | 0.59 | 0.63 | 0.60 | 0.09 |
| Bromomethane | 2.80 | 1.30 | 1.50 | 0.48 | 0.08 |
| 2-Propanone, 1-fluoro | 0.02 | 0.07 | 0.03 | 0.03 | 0.00 |
| Carbon disulfide | 1.25 | 0.24 | 0.25 | 0.22 | 0.04 |
| -Butanone, 3-methoxy, 3-methyl | 0.02 | 0.06 | 0.04 | 0.01 | 0.00 |
| Ethyl ether | 0.09 | 0.10 | 0.12 | 0.02 | 0.00 |
| Phenol | 0.00 | 0.02 | 0.00 | 0.04 | 0.00 |
| Naphthalene | 1.29 | 0.64 | 0.64 | 0.58 | 0.10 |
| Chlorobenzene | 1.32 | 0.45 | 0.45 | 0.22 | 0.04 |
| o-Cresol | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| p-Cresol | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 |
| 1,2-Dichlorobenzene | 2.36 | 1.31 | 1.41 | 0.60 | 0.10 |
| Benzenamine | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 |
| Hexone (MIBK) | 0.08 | 0.11 | 0.14 | 0.02 | 0.00 |
| Benzyl alcohol | 0.08 | 0.04 | 0.02 | 0.04 | 0.00 |
| Pentane, 3-meth, 2,2,4-trimethyl | 0.81 | 0.43 | 0.46 | 0.16 | 0.03 |
| Dimethyl disulfide | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| Dimethyl sulfide) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TOTAL | 40.40 | 14.66 | 15.31 | 7.01 | 1.06 |

presents the estimated annual release rate for each constituent after control from the proposed facilities and from the existing facilities. The maximum short-term controlled release rates, by constituent for all other scenarios are provided in Table 10.6.5-2 for the air system and Table 10.6.5-3 for the oxygen system.

Because comparison of the proposed controlled emission rates to existing annual VOC emissions yields a net reduction from Deer Island and Nut Island baseline levels, the control systems required for both Deer and Nut Island facilities must represent BACT. Also, this indicates that regulatory requirements are met with the use of BACT as opposed to LAER, and that the VOC emissions from the proposed facilities are not required to be offset.

For the facilities proposed for Deer Island, the distribution of emissions by treatment unit indicates that the great majority of the releases occur prior to reaching the secondary clarifiers. (See Table 10.6.5-4.) Most of these emissions come from turbulence as wastewater flows over weirs. Table 10.6.5-4 also shows that total uncontrolled emissions of PPL/HSL VOCs from oxygen activated sludge are about 8 tons per year less than from air activated sludge (98 tons per year versus 106 tons per year)..

## 10.6.6 EVALUATION OF SYSTEMS FOR CONTROLLING EMISSIONS

This section reviews available technologies for both odor and VOC abatement and identifies technologies appropriate for use at Deer Island. The section recommends a technology that should be subjected to a detailed analysis for incorporation in the final design.

The technologies evaluated include pollutant removal or control from the wastewater before the pollutants are released to the atmosphere, and collection and control of air streams.

### Control Technologies for Liquid Streams

The potential for release of odors from wastewater can be decreased by treating the liquid stream. Some of the methods available include chemical oxidation, raising the oxidation/reduction potential, and pH control.

Chemical oxidation is obtained by adding chlorine, ozone, hydrogen peroxide, or potassium permanganate to wastewater. These chemicals can inhibit the growth of bacteria that produce the odorous compounds. The added chemical can also oxidize the compounds. For example, chlorine can oxidize sulfide to sulfate.

Oxidation/reduction control can be achieved by adding dissolved oxygen or nitrate to wastewater. With oxygen or nitrate present, sulfide will not be produced.

Lime or caustic soda can be added to wastewater to raise the pH high enough (to pH 8 or more) so that hydrogen sulfide will not be released.

TABLE 10.6.5-2

SHORT-TERM CONTROLLED CONSTITUENT EMISSION ESTIMATES
UNDER VARIOUS FLOW AND LOAD CONDITIONS FOR THE
EXISTING AND FUTURE TREATMENT SYSTEMS ON DEER AND NUT ISLANDS
AIR SYSTEM (lb/day)

| | Nut Island | | Deer Island | | | |
|---|---|---|---|---|---|---|
| Constituent | Existing Avg | Proposed Max Flow | Existing Avg | Proposed Min Flow | Proposed Max Flow | Proposed Max Storm |
| Benzene | 0.50 | 0.23 | 3.53 | 1.70 | 1.27 | 1.98 |
| Chloroform | 0.71 | 0.31 | 4.98 | 5.09 | 3.98 | 4.92 |
| Ethylbenzene | 1.35 | 0.55 | 7.58 | 6.55 | 5.97 | 5.34 |
| Methylene chloride | 4.36 | 5.23 | 28.27 | 27.35 | 21.57 | 14.65 |
| Tetrachloroethene | 2.02 | 1.29 | 12.40 | 10.76 | 8.39 | 10.67 |
| Toluene | 1.64 | 8.08 | 17.01 | 13.97 | 10.97 | 8.56 |
| Trans-dichloroethene (1,2) | 1.28 | 0.64 | 7.50 | 4.66 | 3.81 | 3.19 |
| 1,1,1-Trichloroethane | 1.46 | 0.76 | 11.78 | 12.12 | 12.05 | 13.48 |
| Trichloroethene | 1.45 | 0.98 | 9.21 | 10.28 | 10.23 | 12.28 |
| Trichlorofluoromethane | 1.65 | 0.51 | 10.82 | 5.22 | 4.49 | 6.86 |
| Styrene | 1.25 | 0.50 | 8.03 | 6.54 | 5.13 | 6.67 |
| Acetone | 0.53 | 0.21 | 2.37 | 1.72 | 1.10 | 0.86 |
| 2-Butanone | 0.45 | 0.08 | 0.47 | 0.33 | 0.21 | 0.18 |
| Total xylenes | 2.52 | 1.81 | 25.46 | 20.86 | 15.33 | 14.09 |
| 1,1,2,2-Tetrachloroethane | 0.45 | 0.03 | 0.78 | 2.06 | 0.86 | 0.71 |
| Methyl mercaptan | 3.29 | 1.02 | 15.58 | 3.73 | 3.15 | 3.86 |
| Bromomethane | 2.61 | 1.36 | 15.35 | 14.57 | 15.22 | 14.11 |
| 2-Propanone, 1-fluoro | 0.18 | 0.01 | 0.13 | 0.14 | 0.10 | 0.08 |
| Carbon disulfide | 1.21 | 0.49 | 6.86 | 2.18 | 2.23 | 3.53 |
| 2-Butanone, 3-methoxy, 3-methyl | 0.04 | 0.01 | 0.13 | 0.43 | 0.15 | 0.22 |
| Ethyl ether | 0.11 | 0.03 | 0.47 | 1.36 | 0.57 | 0.78 |
| Phenol | 0.24 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Naphthalene | 3.18 | 2.11 | 7.07 | 9.73 | 7.10 | 4.43 |
| Chlorobenzene | 1.23 | 0.50 | 7.23 | 4.26 | 3.12 | 2.86 |
| o-Cresol | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| p-Cresol | 0.26 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| 1,2-Dichlorobenzene | 3.27 | 1.99 | 12.95 | 15.44 | 11.26 | 7.36 |
| Benzenamine | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Hexone (MIBK) | 0.11 | 0.03 | 0.45 | 1.78 | 0.61 | 0.80 |
| Benzyl alcohol | 0.19 | 0.03 | 0.43 | 0.23 | 0.15 | 0.13 |
| Pentane, 3-meth, 2,2,4-trimethyl | 0.88 | 0.33 | 4.46 | 3.63 | 2.65 | 3.42 |
| Dimethyl disulfide | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Dimethyl sulfide | 0.00 | 0.00 | 0.01 | 0.03 | 0.01 | 0.01 |
| TOTAL | 38.43 | 29.12 | 221.37 | 186.77 | 151.71 | 146.07 |

TABLE 10.6.5-3

SHORT-TERM CONTROLLED CONSTITUENT EMISSION ESTIMATES UNDER VARIOUS FLOW AND LOAD CONDITIONS FOR THE EXISTING AND FUTURE TREATMENT SYSTEMS ON DEER ISLAND AND NUT ISLANDS
OXYGEN SYSTEM (lb/day)

| | Nut Island | | Deer Island | | | |
|---|---|---|---|---|---|---|
| Constituent | Existing Avg | Proposed Max Flow | Existing Avg | Proposed Min Flow | Proposed Max Flow | Proposed Max Storm |
| Benzene | 0.50 | 0.23 | 3.53 | 1.69 | 1.26 | 1.95 |
| Chloroform | 0.71 | 0.31 | 4.98 | 4.80 | 3.51 | 3.87 |
| Ethylbenzene | 1.35 | 0.55 | 7.58 | 6.77 | 6.32 | 5.79 |
| Methylene chloride | 4.36 | 5.23 | 28.27 | 26.01 | 19.57 | 12.21 |
| Tetrachloroethene | 2.02 | 1.29 | 12.40 | 10.15 | 7.37 | 8.30 |
| Toluene | 1.64 | 8.08 | 17.01 | 14.22 | 11.38 | 9.13 |
| Trans-dichloroethene (1,2) | 1.28 | 0.64 | 7.50 | 4.31 | 3.19 | 2.27 |
| 1,1,1-Trichloroethane | 1.46 | 0.76 | 11.78 | 10.92 | 8.05 | 6.58 |
| Trichloroethene | 1.45 | 0.98 | 9.21 | 10.53 | 10.62 | 12.90 |
| Trichlorofluoromethane | 1.65 | 0.51 | 10.82 | 4.60 | 3.41 | 4.15 |
| Styrene | 1.25 | 0.50 | 8.03 | 6.16 | 4.52 | 5.24 |
| Acetone | 0.53 | 0.21 | 2.37 | 1.71 | 1.09 | 0.85 |
| 2-Butanone | 0.45 | 0.08 | 0.47 | 0.33 | 0.21 | 0.18 |
| Total xylenes | 2.52 | 1.81 | 25.46 | 20.72 | 15.09 | 13.63 |
| 1,1,2,2-Tetrachloroethane | 0.45 | 0.03 | 0.78 | 1.64 | 0.67 | 0.53 |
| Methyl mercaptan | 3.29 | 1.02 | 15.58 | 6.50 | 4.92 | 5.47 |
| Bromomethane | 2.61 | 1.36 | 15.35 | 13.78 | 10.73 | 7.31 |
| 2-Propanone, 1-fluoro | 0.18 | 0.01 | 0.13 | 0.13 | 0.10 | 0.08 |
| Carbon disulfide | 1.21 | 0.49 | 6.86 | 2.38 | 1.83 | 2.14 |
| 2-Butanone, 3-methoxy, 3-methyl | 0.04 | 0.01 | 0.13 | 0.40 | 0.14 | 0.20 |
| Ethyl ether | 0.11 | 0.03 | 0.47 | 1.08 | 0.44 | 0.58 |
| Phenol | 0.24 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Naphthalene | 3.18 | 2.11 | 7.07 | 9.69 | 0.70 | 4.36 |
| Chlorobenzene | 1.23 | 0.50 | 7.23 | 4.23 | 3.07 | 2.77 |
| o-Cresol | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| p-Cresol | 0.26 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| 1,2-Dichlorobenzene | 3.27 | 1.99 | 12.95 | 15.00 | 10.75 | 6.73 |
| Benzenamine | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 |
| Hexone (MIBK) | 0.11 | 0.03 | 0.45 | 1.67 | 0.57 | 0.74 |
| Benzyl alcohol | 0.19 | 0.03 | 0.43 | 0.23 | 0.14 | 0.13 |
| Pentane, 3-meth, 2,2,4-trimethyl | 0.88 | 0.33 | 4.46 | 3.53 | 2.53 | 3.12 |
| Dimethyl disulfide | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Dimethyl sulfide | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| TOTAL | 38.43 | 29.12 | 221.37 | 183.22 | 132.21 | 121.24 |

TABLE 10.6.5-4

DISTRIBUTION OF AIR EMISSIONS BY TREATMENT UNIT

| | Air Activated Sludge | | Oxygen Activated Sludge | |
|---|---|---|---|---|
| | Uncontrolled | Controlled | Uncontrolled | Controlled |
| Grit Chamber, weir | 18.65 | 2.59 | 18.65 | 2.59 |
| Primary Splitter Box | 28.34 | 3.94 | 28.34 | 3.94 |
| Clarifier weir | 14.26 | 1.98 | 14.26 | 1.98 |
| Secondary splitter box | 23.04 | 3.20 | 23.04 | 3.20 |
| Aeration basin | 16.08 | 2.09 | 3.98 | 0.58 |
| Aeration basin weir | 5.11 | 0.62 | 8.69 | 1.06 |
| Secondary clarifier surface | 0.42 | 0.42 | 0.54 | 0.54 |
| Secondary clarifier weir | 0.40 | 0.40 | 0.66 | 0.66 |
| Chlorine contact | 0.09 | 0.09 | 0.11 | 0.11 |
| TOTAL | 106.39 | 15.33 | 98.27 | 14.66 |

EMISSIONS OF PPL/HSL VOCs IN TONS PER YEAR
(Based on average flows and loads, weighted by high and low groundwater)

Sum of PPL/HSL VOCs to Deer Island = 307 tons per year

These systems have been used in wastewater systems and treatment plants. However, to be conservative in analyses of emissions from the Deer Island plant and the Nut Island headworks, the use of chemicals to decrease the potential for odors was not considered. The equipment to control odors was sized to be adequate without adding chemicals to pretreat the liquid stream.

Control Technologies for Air Streams

Odor-producing compounds and VOCs in air streams can be controlled by collecting the air streams and treating them before release to the atmosphere.

Available treatment technologies include: ozonation, wet scrubbing with a mist chamber, wet scrubbing with a packed tower, carbon adsorption, incineration, and condensation. Some processes are applicable for both odor and VOC control; some are applicable for either one or the other, but not for both.

Ozonation

In an ozonation system, odorous air is contacted with ozone in a long, baffled chamber to promote mixing and oxidation of the odorous compounds. A typical ozonation system produces ozone from clean dry air and diffuses the ozone into a contact chamber where the ozone oxidizes the odorous compounds.

To date, the use of ozone systems has been limited to odor control, rather than VOC control. Based on past operating experience, ozone systems have not proven to be effective for odor control. Ozone manufacturers originally promoted the use of ozone in odor control systems because ozone rapidly oxidizes many odorous compounds in the aqueous phase. In the gaseous phase, however, ozone systems oxidize only a small portion of the odorous compounds present. Instead of oxidizing the others, ozone simply masks their odors. When the exhaust from an ozone system is dispersed from the source, the ozone can degrade to oxygen and the original odors will reappear. If too much ozone is added, the high levels of unreacted ozone in the exhaust can promote odor complaints because ozone has a sharp, acrid smell. It may also be a health hazard, since ozone is toxic at concentrations above 1 ppm.

Wet Scrubbing

Control of gaseous contaminants can be accomplished by liquid scrubbing. In this method, a contaminated gas stream is brought into contact with a scrubbing liquid, allowing contaminant gases to be absorbed into the liquid. The cleaned gas is then separated from the contaminated liquid, which may be collected and treated. The rate of mass transfer of the contaminating gas into the scrubbing liquid is proportional to the gas-liquid interface surface area. Scrubbing units are therefore designed to provide large liquid surface areas. Typical unit designs include packed towers, spray towers, mist chambers, and venturi absorbers.

The efficiency of wet scrubbers can be enhanced by using caustic soda . The caustic soda increases the pH of the solution to increase solubility of hydrogen sulfide

Scrubbing is very effective for removing odors because of the high solubility of hydrogen sulfide in high-pH solutions. Scrubbing is less effective, however, in removing VOCs. VOCs are generally less soluble, and, because of their very low concentration in exhaust air streams from wastewater treatment processes, significant mass transfer of the organics from the gas to a scrubber liquid is difficult to obtain. Thus for both odor and VOC control, a wet scrubber would require a downstream polishing component to control the organic component.

Mist chambers (Figure 10.6.6-1) produce a fine aerosol mist or fog through which odorous gases are passed. Compressed air and the oxidizing/neutralizing liquid are introduced through nozzles designed to produce a very fine mist (5 to 10 microns), which produces a very large surface area for transfer between phases. The treated air exits from the top of the chamber, and the liquid drains from the bottom. With a mist chamber, there is no recirculation of caustic soda solution. To prevent blockage of the fine nozzles, softened potable water must be used to prepare the chemical solutions.

Mist chambers are widely used in industrial applications, where odors can be very severe. Mist chambers have also been installed at some municipal wastewater plants.

Advantages of the mist chamber, when compared to a packed bed scrubber (which is described below) include: no packing or chemical recirculation; lower pressure drop through the chamber; and the high surface area of the small mist droplets and long detention time in the chamber which increase the probability that odorous air molecules will come in contact with the scrubbing chemical.

Some of the disadvantages include complexity, large space requirements and maintenance of air compressors, water softeners and chemical feed systems. Mist chambers are typically larger than packed towers because of the increased detention time used, and the mist nozzles require frequent cleaning to remove chemical deposits caused by the scrubbing solution and the oxidation reactions.

Because of the low solubility of VOCs in scrubbing liquid, scrubbing is usually not considered effective for removing VOCs. However, recent work done with mist chambers at composting operations shows high removals of VOCs. These surprising results might be attributed to surface effects allowing for removals much higher than calculated by Henry's law relationships.

Packed tower scrubbers are filled with plastic media to create turbulence and increase interface area between the liquid and the air being treated. (See Figure 10.6.6-2.) In the tower, the odorous air and chemical solution are contacted in a fiberglass spray tower. A scrubbing liquid is recirculated from a sump at the base of the tower. Often make-up chemicals are added to the sump to revive the potency of the recirculated scrubbing liquid.

There are numerous packed tower scrubbing systems at wastewater treatment plants today. Advantages of the packed tower scrubbers include a lower space requirement than the mist

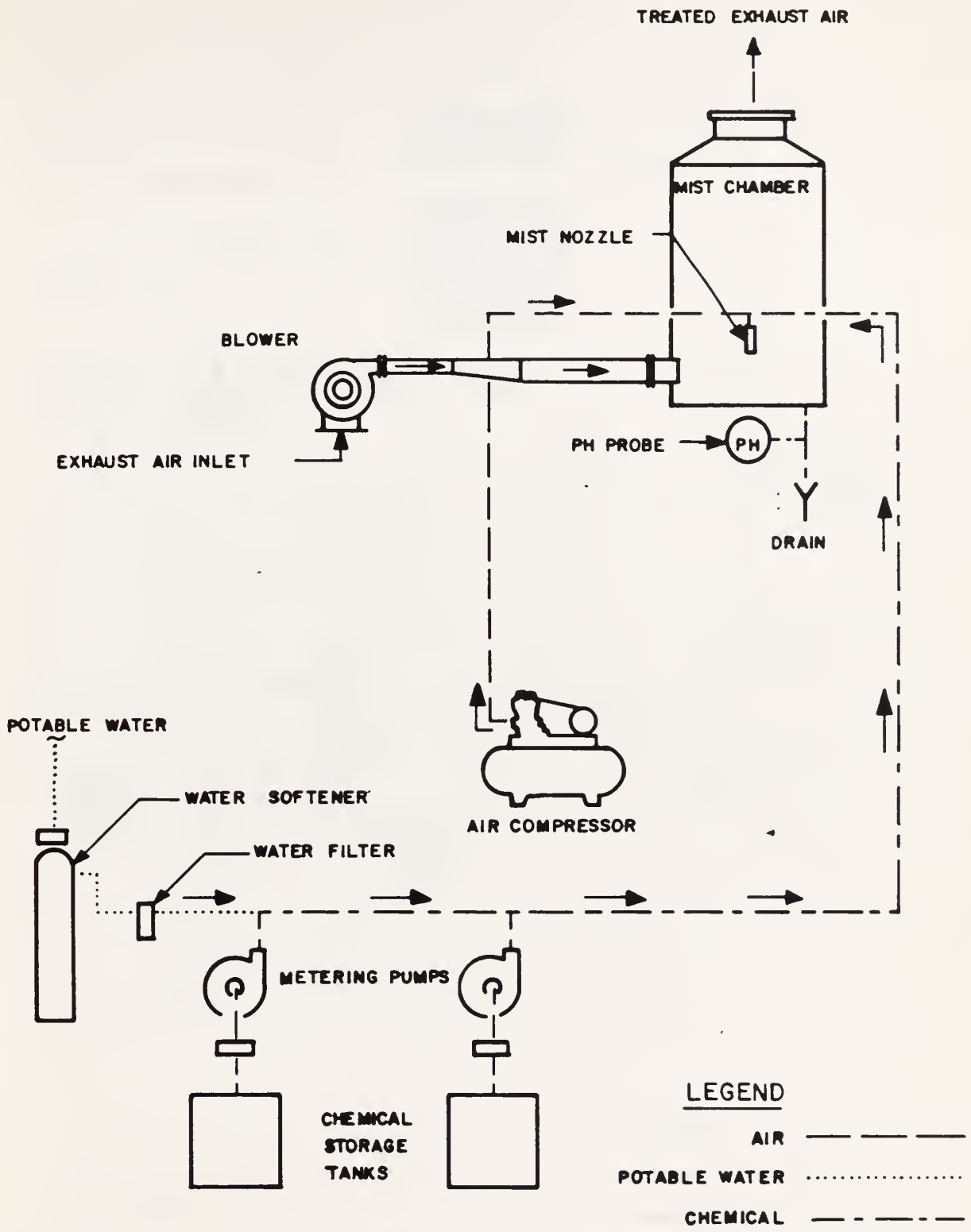



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FIGURE 10.6.6-1
SCHEMATIC DIAGRAM OF
MIST - CHAMBER SCRUBBER

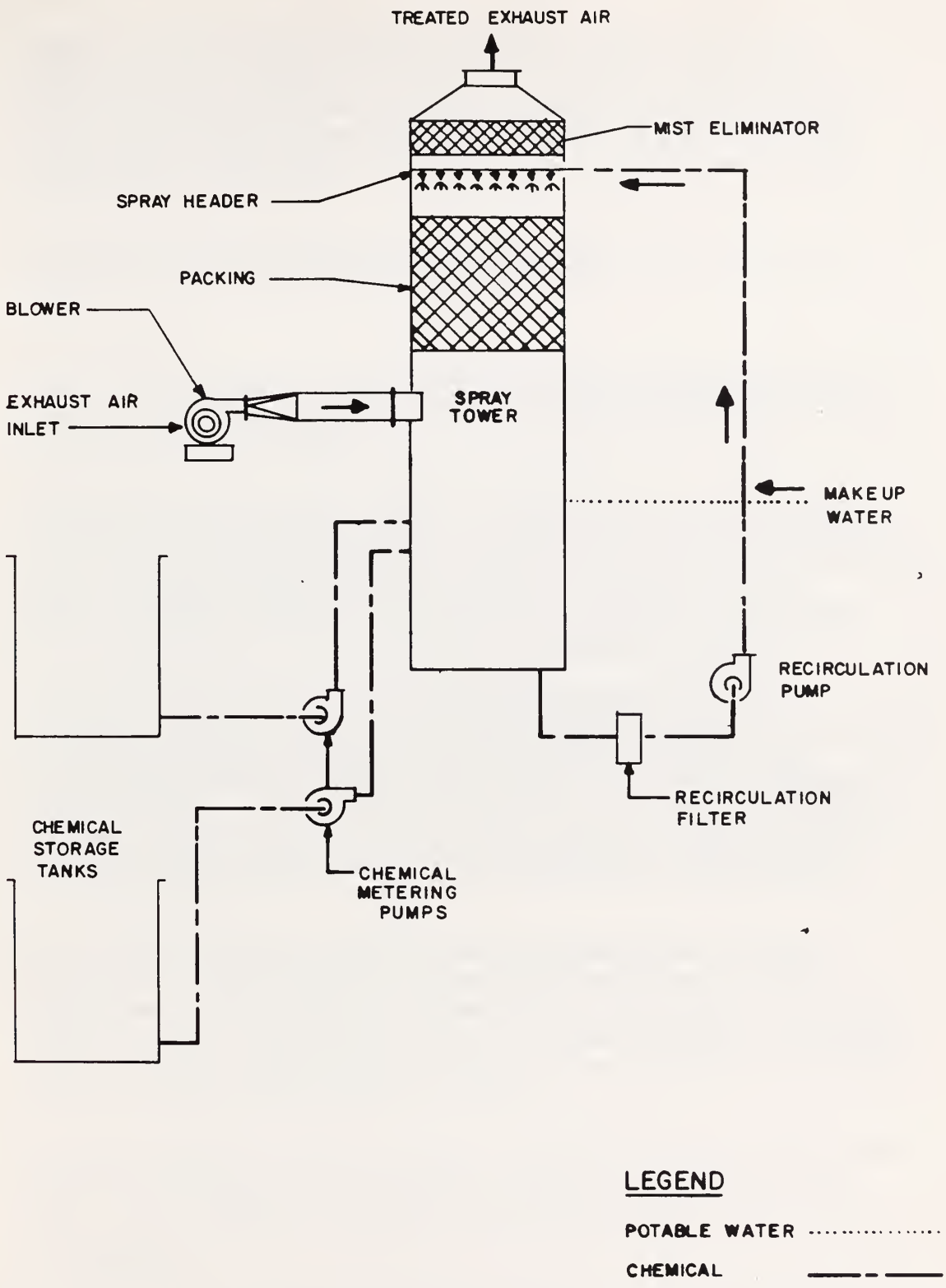


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FIGURE 10.6.6-2
SCHEMATIC DIAGRAM OF
PACKED - TOWER SCRUBBER

chambers. The system is also somewhat easier to operate and maintain, and has a good performance record on removing odors (particularly from reduced sulfur compounds) from air streams at wastewater treatment plants. In addition, it is important to remove all water and chemicals from the scrubber exhaust if the scrubber is followed by a carbon system, and the larger droplets of the packed tower are more easily removed in a mist eliminator than much smaller droplets of a mist chamber.

Disadvantages when compared to a mist chamber include a higher pressure drop through the packing and a somewhat lower efficiency for controlling odors.

Carbon Adsorption

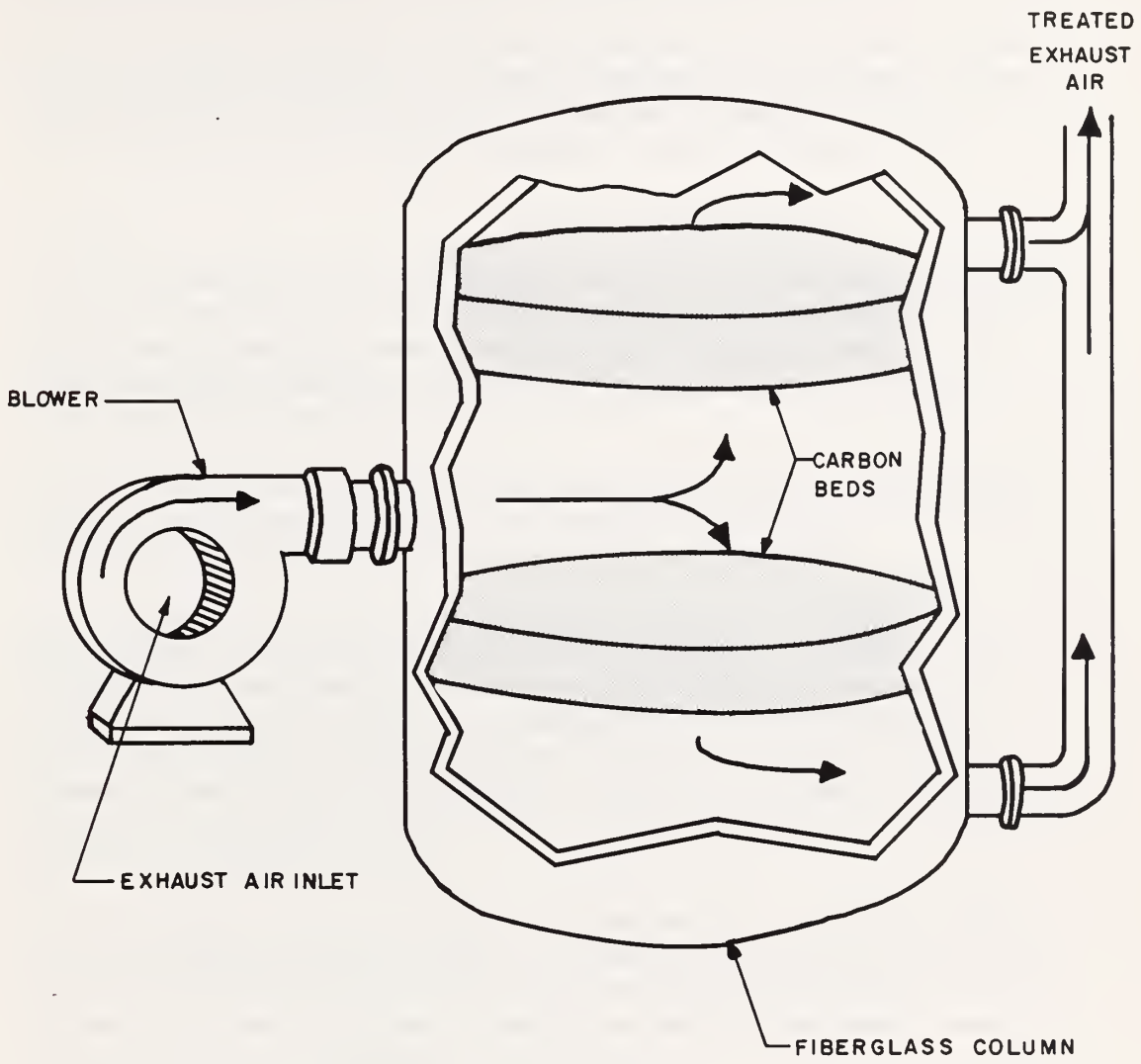
Granular activated-carbon systems have been through many years of refinement and technical development . They also have good operating records at wastewater treatment plants, and can be used for both odor and VOC control.

Carbon adsorption systems typically consist of beds of activated carbon ranging from about 24 to 48 inches in depth. (See Figure 10.6.6-3.) Air enters the vessel and flows through the bed where the VOCs and odor-causing compounds are adsorbed onto the carbon. After adsorption, the treated air is discharged through a stack to the atmosphere. Once the carbon bed is saturated, regeneration of the carbon is required by one of two methods: on-site regeneration with low pressure steam, or off-site regeneration involving total carbon replacement.

Adsorption of VOCs onto activated carbon is an accepted process for control of low concentrations of VOCs in air streams. Carbon adsorption systems are available from a number of manufacturers with unique configurations and operating procedures. Initially, carbon adsorption systems were used by industry to recover solvents from air streams containing high solvent concentrations. Recently, however, these systems have also been applied to remove low concentration VOCs from exhaust air streams. Several manufacturers of carbon adsorption systems have systems in operation that decrease VOC concentrations in an exhaust stream to below 5 ppm by volume.

For odor control, a proprietary activated carbon that is specifically designed for removal of hydrogen sulfide is available. The carbon is impregnated with sodium hydroxide, which chemically reacts with and neutralizes any hydrogen sulfide in the gas stream. The impregnated carbon can also remove large, nonpolar molecules such as organic hydrocarbons, by adsorbing or trapping these molecules within the carbon pores. Thus, odorous compounds can be removed by one of two mechanisms: chemical reaction or adsorption.

A new process involving the injection of ammonia into a gas stream entering an activated carbon bed is being investigated at the Owl's Head plant in New York City. The ammonia acts as a catalyst in a series of reactions transforming hydrogen sulfide to elemental sulfur. The use of small volumes of ammonia has increased the amount of sulfur that can be adsorbed before the bed is regenerated.




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 10.6.6-3<br>SECTION OF DUAL - BED<br>ACTIVATED CARBON COLUMN |
|---|---|

Advantages of carbon adsorption include ease of operation, reliability in controlling a wide range of odors, and the capability of removing VOCs in addition to odors. The disadvantages include high head loss through the adsorber, and carbon regeneration or replacement costs. Also, operating problems can occur in applications with high moisture contents.

Carbon can be thermally reactivated on-or offsite or chemically regenerated onsite. To extend the life of a carbon bed, scrubbers are typically used upstream of carbon adsorbers to remove the majority of odors, leaving the carbon as a polishing unit. The regeneration process produces a wash, either gaseous or liquid, that requires treatment for disposal.

Incineration

Incineration is commonly used for VOC emission control and is quite capable of achieving a very high degree of VOC destruction. Various forms of incineration have been applied including flame, thermal, and catalytic incineration. Most incinerator manufacturers state that their systems are capable of reducing VOC emissions by 90 to 95 percent, even with low VOC concentrations in the inlet air stream.

Flame incineration is often used to remove VOC emissions when high concentrations support combustion. VOC concentrations in exhaust air streams from wastewater treatment processes are well below the lower combustion limit, thus flame incineration is not practical.

Thermal incineration involves elevating the VOC-laden air temperature to 1400 to 1500 deg F and providing sufficient residence time to oxidize the organic contaminants. VOC-laden air is first passed through heat exchangers and preheated by the combustion gases exiting the unit. The process of preheating the air increases the thermal efficiency of the incineration by reducing fuel consumption. The air is then heated to 1400 deg F by auxiliary fuel in the combustion chamber, where the VOCs are oxidized. The hot exhaust gas passes through the heat exchangers and is discharged to the atmosphere. A secondary heat exchanger may be located downstream for additional heat recovery.

Catalytic incineration is sometimes used for VOC emission reduction. The catalyst increases the rate of oxidation by adsorbing the VOCs on its surface, thereby allowing the VOC-laden air to be oxidized at a lower temperature. Typical oxidation temperatures for catalytic incinerators range from 550 to 750 deg F. Catalysts can either be a precious metal coating on a ceramic structure or a fluidized bed of non-precious metal.

Catalytic incinerators are more costly than thermal incinerators, but fuel consumption is significantly less. The primary disadvantage of catalytic incineration is the potential for poisoning of the catalyst. Chemicals known to poison catalysts include chlorine, fluorine, and phosphorus, as well as metals such as lead, zinc, and mercury. VOCs emitted from wastewater treatment processes vary considerably and the risk of catalyst poisoning is great. For this reason catalytic incineration systems are not used for controlling VOC emissions from wastewater treatment processes.

Condensation

Another technique for removal of gaseous VOC contaminants from an exhaust air stream utilizes the principle of condensation. In this method, the gas stream is cooled below the dew point of water and of organic constituents, and the liquid is condensed and collected. It is necessary to have a vapor with a high dew point and high concentrations of contaminants for this method to be practical. In addition, this method is economically feasible only in situations where the recovery of the contaminant is profitable. Therefore, this method is not a practical alternative for control of the air streams at a wastewater control plant.

Summary of Control Technologies for Air Streams

Several control systems are in common use for decreasing the concentration of odor-producing compounds and VOCs in gas streams. Of these, the most reliable control system for both odors and VOCs is wet scrubbing followed by activated carbon. Wet scrubbing would be used to remove odor-causing compounds, and the off gas from the scrubbers would be directed to carbon adsorbers where residual hydrogen sulfide as well as VOCs would be removed. The overall removal efficiency for the system would be 95 to 99 percent for hydrogen sulfide and other reduced sulfur species, and about 85 percent for VOCs.

For cost purposes and for preliminary site layouts, single-stage wet scrubbing has been used, followed by carbon adsorption. During final design, additional studies should be conducted to determine the most cost-effective method. The studies would investigate removal of individual VOCs at low concentrations.

The carbon system would consist of fixed-bed adsorption units that would require regular on-site desorption and periodic off-site carbon regeneration. Based on the low VOC concentration, carbon regeneration would be required approximately every year. The desorption cycle would be required every 2 to 4 days.

Demonstration of Best Available Technology

The justification of BACT is impacted by the selection of wastewater-treatment processes for which a control system is proposed. In the case of Deer Island, air pollution control systems are proposed for the entire facility up to and including the aeration tanks. The secondary clarifiers and the disinfection tanks will remain uncovered and uncontrolled with respect to air emissions.

To demonstrate that a selected control system represents BACT, it is necessary to evaluate its energy, economic, and environmental impacts. Impacts on energy consumption are deemed adverse when the selected system requires an exorbitant amount of energy or a source of energy not readily available within the area. Economic impacts are deemed adverse when the annualized cost of control exceeds a certain predefined amount. Using EPA practice, control is necessary when the annual cost of control is less than or equal to $5000 per ton of pollutant removed. Environmental impacts are deemed adverse when the ambient impacts of the released pollutants

exceed critical environmental levels established for the project under review. in this case the AALs.

Table 10.6.6-1 presents a summary of the emission calculations presented previously for the flow and load conditions that represent the annual operating regime for the oxygen activated sludge system. This table shows an uncontrolled emission rate for the PPL/HSL constituents equal to 98 tons/yr and a controlled rate equal to 15 tons/yr. The total VOC emission estimates are based on the range of the total VOC-to-PPL/HSL constituents relationship reported earlier as 20 to 50.

As shown on the table, the proposed control system -- covering and control of our emissions up to the secondary clarifiers - - will reduce the total VOC emissions from the treatment plant by an amount ranging between 1700 and 4200 tons/yr. Preliminary cost estimates indicate that the annual cost of control is about $800,000 for the primary treatment units and $1,800,000 for the secondary treatment units. The costs for secondary treatment do not include the cost of the basin covers because covers are required in an oxygen activated sludge system. The amount of VOCs controlled in each unit ranges from 1050 to 2640 tons/yr in the primary-treatment system and 620 to 1540 tons/yr in the secondary-treatment system. These values equate to a unit cost of about $300 to 760/ton of VOC removed in the primary-treatment system and about $1180 to $2960/ton of VOC removed in the secondary-system. These costs are less than $5000/ton and can be considered to be BACT.

The uncontrolled sources remaining are of the secondary clarifiers and the disinfection tank. Two potential options for control exist: additional stripping and control of volatile constituents in the aeration basin; or installation of a capture and control system on the secondary clarifiers and disinfection tanks.

The first option will yield little reduction in the annual controlled VOC emission rate. Table 10.6.5-4 shows that the controlled emissions of PPL/HSL VOCs would change only about 5 percent (15.33 tons per year vs 14.66 tons per year) if air were used to aerate the activated sludge system. It was judged, however, that the oxygen-activated sludge system would be more reliable for wastewater treatment. Because of the small difference in emissions between the oxygen and air systems, the more-reliable system (oxygen activated sludge) should be retained.

The second option would involve collection and control of the VOCs released from the uncontrolled treatment units. The emission rate from the disinfection area is so small that collection and treatment of the emission can yield only insignificant reductions. Thus, control of this source is not considered technically or economically feasible. The emissions from the secondary clarifier are essentially equally distributed between the clarifier surfaces and the effluent weirs. The cost to capture the emission far exceeds the economic range of BACT cost effectiveness stated above. For example, the cost of basin covers averages approximately $35/square foot, and the surface area of the secondary clarifiers is approximately 600,000 square feet. The secondary clarifiers will emit between 24 and 60 tons VOC/yr. Complete capture and 85 percent control of this emission will yield a net reduction

**TABLE 10.6.6-1**

**SUMMARY OF ANNUAL EMISSIONS FOR THE OXYGEN FEED SYSTEM BEFORE AND AFTER CONTROL (tons/yr)**

| | Uncontrolled Emissions | | | Controlled Emissions | | |
|---|---|---|---|---|---|---|
| Unit | Individual VOCs | TRS* | Total VOC | Individual VOCs | TRS | Total VOC |
| Grit/Primary Clarifiers | 61.25 | 6.85 | 1225-3062 | 8.51 | 0.35 | 170-426 |
| Aeration Tanks | 35.68 | 5.15 | 714-1786 | 4.84 | 0.26 | 97-242 |
| Secondary Clarifiers | 1.20 | 0.27 | 24 - 60 | 1.20 | 0.27 | 24- 60 |
| Disinfection | 0.11 | 0.02 | 2 - 6 | 0.11 | 0.02 | 2- 6 |
| Total | 98.24 | 12.29 | 1965-4914 | 14.66 | 0.90 | 293-734 |

* Total reduced sulfur

ranging between 21 and 52 tons VOC/yr. The cost to provide the enclosure would be roughly $21 million, and the annualized capital cost for the enclosure would be equal to $2.5 million. Unit costs would range from $48,000 to more than $100,000/ton VOC removed. These costs, even before considering the cost of the equipment, are tremendously excessive and are not representative of BACT.

Summary of BACT System

In summary, the selected control system, consisting of a wet scrubber for odor control followed by an activated carbon adsorber for VOC control is representative of BACT from an economic evaluation standpoint. Implementation of this control strategy will produce a reduction in the VOC emissions from the proposed treatment system of 1672 to 4180 tons/yr, as compared to an uncontrolled scenario. Further capture and control of the VOCs released from the secondary clarifiers and the disinfection tanks does not meet the economic constraints of BACT. Furthermore, this level of capture and control is not practiced anywhere. Finally, the PSD review requirements for TRS (total reduced sulfur) are not triggered, due to the fact that the controlled emission rate for the reduced sulfur species is much less than the 10 tons/yr significant emission level (see section 10.6.2). Upon satisfying the environmental constraints of BACT, the selected air pollution control system will be in full compliance with the provisions of BACT as required by the DEQE.

### 10.6.7 AIR QUALITY MODELING AND AMBIENT IMPACT ASSESSMENT

This section presents the methodology used to conduct an ambient air quality impact assessment of the potential emissions from the proposed wastewater treatment facilities, and concludes with a discussion of the results obtained from the assessment.

An ambient air quality impact assessment is a necessary part of the preconstruction approval process for any proposed source. The potential impacts that are assessed vary from project to project, and can include a comparison of expected ambient air quality impacts of the project with the NAAQS, a PSD increment, an AAL, or an odor threshold for one or many pollutants proposed for release to the atmosphere.

The procedure for ambient air quality impact assessments is based on guidance available from Federal and State air pollution control agencies. The available guidance specifies appropriate methods for estimating a source's potential ambient impact and defines the data required to ensure consistent assessment from source to source and region to region. In the case of preconstruction review, an ambient air quality impact assessment is performed using computer programs that simulate movement of air pollutants between the release point and a ground level impact point (i.e., between a source and a receptor) based on specific source characteristics and detailed meteorological data.

Computer programs used for conducting ambient air quality impact assessments are commonly referred to as "air dispersion models." Many different dispersion models are available and

approved for use by EPA. By selecting the most appropriate dispersion model for the desired purpose at hand, ambient impact assessments can be performed for both particles and gases: in flat terrain, elevated terrain, or some combination of terrain features (terrain is considered elevated when the surrounding land surfaces are above the top of the proposed release point or stack); for short-term averaging times (i.e., 1-h, 3-h, 8-h, or 24-h); and for long-term averaging times (i.e., 30-day, 3-month, annual, or 5-year annual composite).

Objectives of the Current Assessment

The first objective of the current impact assessment is to calculate the expected worst-case air-quality impact of emissions from facilities proposed at Deer Island and Nut Island. The calculated impacts will then be compared to the most critical allowable ambient impact measure applicable to the project. The ultimate objective is to demonstrate that the worst-case ambient air quality impacts for all pollutants expected to be released from the proposed facilities will be less than the allowable levels.

Source Configurations

All of the wastewater units at Deer Island up to and including the effluent weirs of the aeration tanks will be covered. The air pollutant emissions from these units will be treated in a wet scrubber/activated carbon control system prior to being released to the atmosphere through one of several stacks on the Island. Emissions from the remaining sources, i.e., the secondary clarifiers and the disinfection basins, will be released to the atmosphere without control over a large area represented by the surfaces of the treatment units. Figure 10.6.7-1 presents a block flow diagram that describes the relationship between emission source and air pollution control equipment on Deer Island. Table 10.6.7-1 presents similar information in tabular form.

To accurately model the pollutant dispersion, the parameters of each release must be defined in terms of location, strength, height, temperature, momentum, and buoyancy.

Source Locations

Figure 10.6.7-2 presents a diagram of Deer Island that shows the placement of the various wastewater treatment units and the locations of the air pollution control equipment. The locations of sources were established using the Universal Transverse Mercator (UTM) coordinate system. Coordinates were established for the point sources at the point of release; for areas sources, the southwest corner coordinates were obtained after 45 deg rotation into a north-south orientation, as required by the dispersion model.

Emission Source Parameters

Stack parameters were established for the primary treatment control system stacks and the secondary treatment control system stacks at Deer Island. The stack heights were established as the Good Engineering Practice (GEP) stack height required to avoid plume downwash. The buildings in the areas of the stacks will meet the definition of "squat-type" in that the

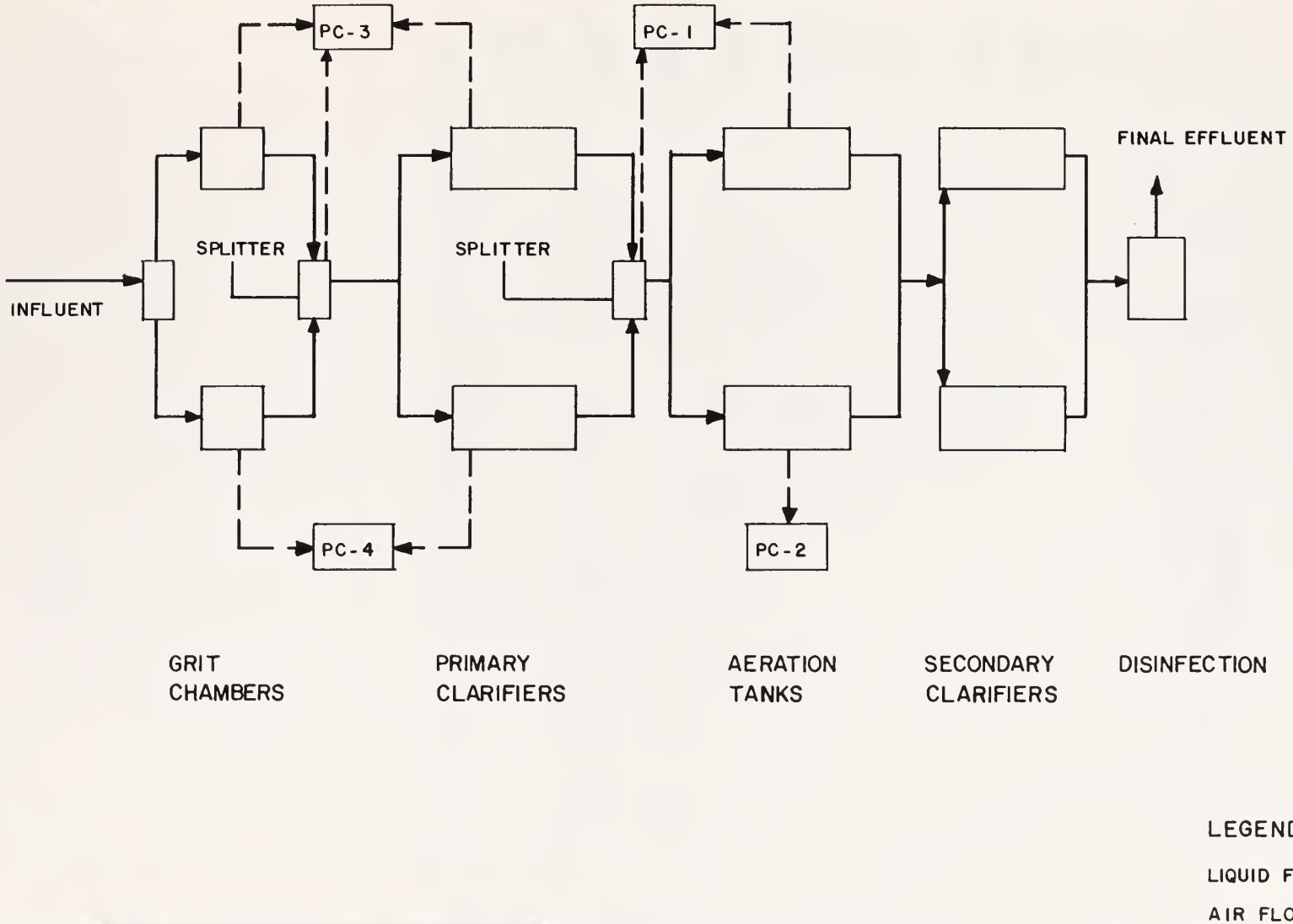



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**FIGURE 10.6.7-1**
**CONTROL EQUIPMENT ORIENTATION USED FOR AIR QUALITY MODELING**

## TABLE 10.6.7-1

## FRACTIONS OF EMISSIONS ALLOCATED TO EMISSION POINTS

| Treatment Unit | Emission Point | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PC-1 | PC-2 | PC-3 | PC-4 | AR-5 | AR-6 | AR-7 | AR-8 | AR-9 |
| Grit Chambers | 0.5 | 0.5 | | | | | | | |
| Primary Splitter | 1.0 | | | | | | | | |
| Primary Weir | 0.5 | 0.5 | | | | | | | |
| Aeration Splitter | | | 1.0 | | | | | | |
| Aeration Tank | | | 0.5 | 0.5 | | | | | |
| Aeration Weir | | | 0.5 | 0.5 | | | | | |
| Secondar Clarifier | | | | | 0.25 | 0.25 | 0.25 | 0.25 | |
| Secondary Weir | | | | | 0.25 | 0.25 | 0.25 | 0.25 | |
| Disinfection Basin | | | | | | | | | 1.0 |

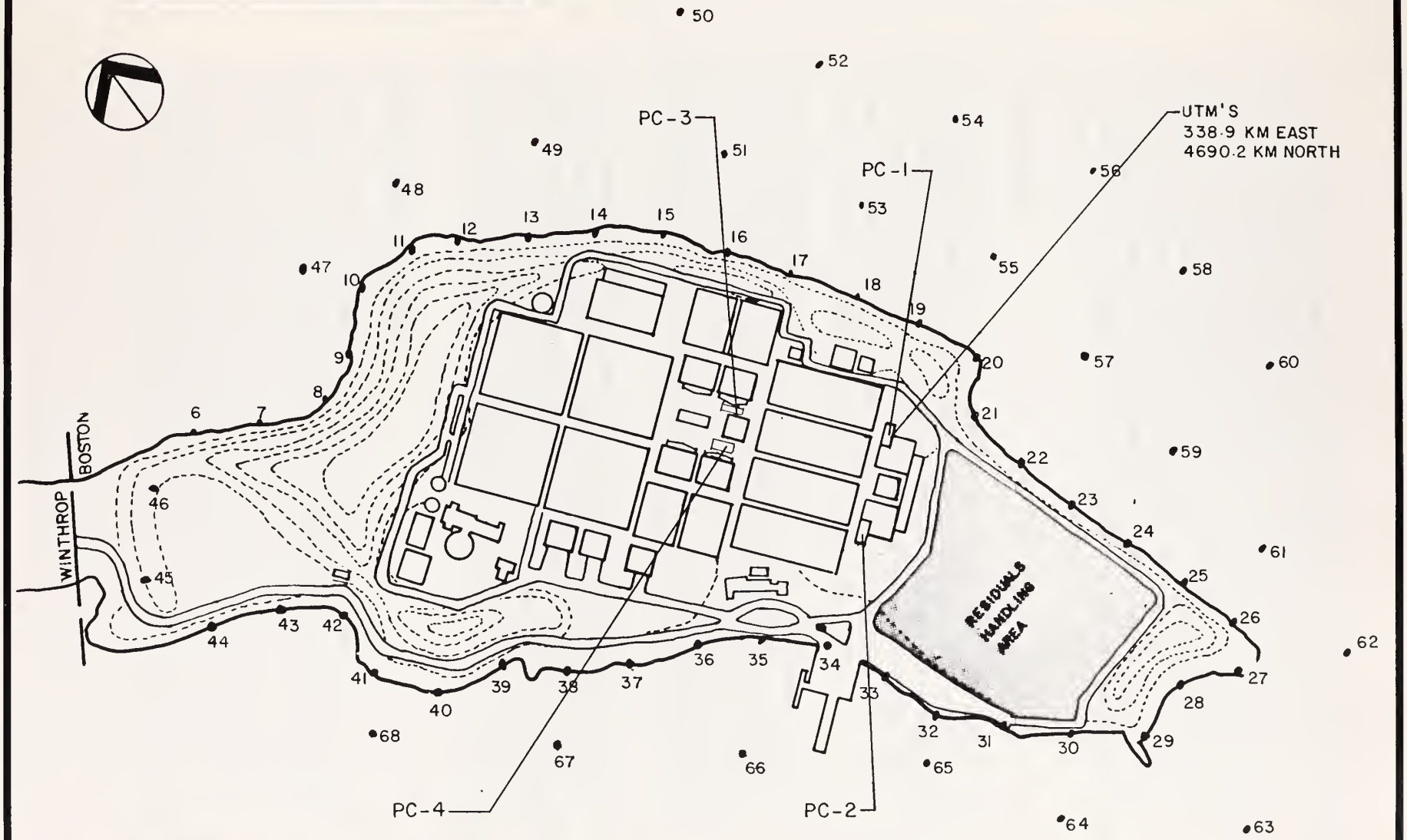


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**FIGURE 10.6.7-2**
**EMISSION CONTROL FACILITIES AND RECEPTORS**

length and width will be greater than the height; thus GEP was defined as 2.5 times the height of the nearest building. In all cases, the nearest building was 30 ft high.

The stacks were assumed to be identical within each treatment area, even though one of the stacks in each area will handle a greater air flow. This assumption was made for practical reasons in that the plant is likely to be built symetrically. The design stack diameter is based on an exit velocity of about 60 fps at the condition of maximum flow. The actual velocity input to the model was then calculated based on the actual flow exiting the stack under normal operating conditions. All temperatures were assumed to be at ambient conditions of 68 deg F.

Screening Analysis

The first step in the dispersion modeling analysis was to set up a screening model, i.e., an analysis designed to determine if the ambient impact of emissions of each constituent could possibly exceed the critical ambient concentration for that constituent. A secondary purpose of the screening modeling was to provide a methodology to establish critical receptor locations. This level of assessment is consistent with the EPA Guideline on Air Quality Models (U.S.EPA, EPA-450/2-78- 002R) for determining receptor grids.

Rationale and Model Selection. Two types of sources are proposed for Deer Island. These include the four point sources (stacks) and the area sources representing the secondary clarifiers and disinfection basins. Because no approved procedures exist for screening level analyses of area sources, area sources were not treated in the screening level analysis. (For receptor placement, however, area sources typically result in maximum concentrations at a distance approximately equal to the length of one side from the downwind edge.)

The EPA-approved PTPLU Model provides a simple screening tool for determining short-term maximum impacts of point source emissions. It is able to quickly model many stack configurations using a large number of meteorological conditions. This allows consideration of dispersion of individual sources under a variety of different conditions and estimation of the 1-hour concentrations associated with each condition. The 1-hour concentration estimates were subsequently adjusted to a 24-hour averaging period for comparison with the allowable impact levels.

Screening Modeling and Results

Application of the PTPLU Model was consistent with general modeling practice, i.e., each point source was input to the model with its given stack parameters and the appropriate control options selected. Because of limitations in the treatment of area sources, only pollutants estimated to be released entirely from a point source were considered in the screening analysis. The results of the PTPLU analysis were reviewed to determine the maximum concentrations for meteorological conditions consistent with a 24-hour average. For example, a neutral stability condition was thought to be reasonable for consideration, while the occurrence of the maximum concentration with a strongly unstable condition was not thought to be a reasonable condition that would occur over a 24-hour period. For conservatism, however,

the maximum one-hour concentration was selected regardless of meteorological conditions.

Four separate emissions sources were modeled corresponding to the four stacks that will be located on the Deer Island site. The rural option of the model was selected to be consistent with land use surrounding Deer Island.

Pollutants were not screened if any portion of the emissions were from one of the uncontrolled area sources. Constituents released from both point and area sources were evaluated only in the detailed modeling assessment. Based on calculations of emissions, virtually one hundred percent of the potential emissions of the following pollutants are from point sources:

- o benzene
- o ethylbenzene
- o methylene chloride
- o tetrachloroethene
- o toluene
- o trans-dichloroethene (1.2)
- o trichloroethene
- o trichlorofluoromethane
- o acetone
- o 2-butanone
- o total xylenes
- o napthalene
- o chlorobenzene
- o benzyl alcohol

The maximum 1-h concentrations derived from the PTPLU analysis are presented for each of the four stacks in Table 10.6.7-2. For each point source, two concentration estimates are presented. The first concentration represents the maximum 1-h value derived from the PTPLU output. The second concentration represents the 24-h adjusted concentrations. For this analysis, an adjustment factor of 0.4 as recommended by EPA was used to convert from a 1-h to a 24-h concentration.

Review of the results in Table 10.6.7-2 indicates that the maximum impacts will typically occur within about 300 m of the individual sources. Because the shorelines are within this distance, the maximum impacts might occur at the shoreline. Further review of the PTPLU results for other wind speed/stability class combinations indicates that maximum concentrations could be expected to occur at downwind distances of 500 m or less for all meteorological conditions. These results formed the basis for selection of appropriate downwind distances in the detailed analysis described in the next section.

Using the results presented in Table 10.6.7-2 along with the pollutant specific emissions for a maximum load/minimum flow scenario resulted in the 24-hour pollutant-specific concentration estimates of Table 10.6.7-3.

TABLE 10.6.7-2

UNIT RESULTS OF PTPLU SCREENING ANALYSIS
OF POINT SOURCES*

| Source | Normalized Maximum 1-h Concentration, $\mu g/m^3$ | NormalizedMaximum 24-h Concentration, $\mu g/m^3$ | Distance to Maximum, m |
|---|---|---|---|
| PC-1 | 20.28 | 8.11 | 256 |
| PC-2 | 31.39 | 12.56 | 265 |
| PC-3 | 39.19 | 15.68 | 287 |
| PC-4 | 47.78 | 19.11 | 263 |

*Based on 1gm/sec emission

TABLE 10.6.7-3

MAXIMUM 24-HR POLLUTANT-SPECIFIC SCREENING RESULTS ($ug/m^3$)

| Constituent | Maximum 24-h Concentration | | | | | AAL | 1/2 AAL | Omit? |
|---|---|---|---|---|---|---|---|---|
| | PC-1 | PC-2 | PC-3 | PC-4 | Total | | | |
| Benzene | 0.04 | 0.02 | 0.04 | 0.00 | 0.10 | 4.0 | 2.0 | Y |
| Ethylbenzene | 0.12 | 0.06 | 0.18 | 0.06 | 0.42 | 120 | 60 | Y |
| Methylene chloride | 0.62 | 0.32 | 0.55 | 0.00 | 1.49 | 8.0 | 4.0 | Y |
| Tetrachloro-ethene | 0.32 | 0.12 | 0.22 | 0.00 | 0.66 | 20.6 | 10.3 | Y |
| Toluene | 0.31 | 0.16 | 0.33 | 0.06 | 0.86 | 51.0 | 25.5 | Y |
| Trans-dichloro-ethene (1,2) | 0.10 | 0.05 | 0.09 | 0.00 | 0.25 | 110 | 55 | Y |
| Trichloro-ethene | 0.17 | 0.08 | 0.30 | 0.18 | 0.72 | 20.4 | 10.2 | Y |
| Trichloro-flouro-methane | 0.11 | 0.06 | 0.09 | 0.00 | 0.26 | 762 | 381 | Y |
| Acetone | 0.04 | 0.02 | 0.05 | 0.00 | 0.11 | 8000 | 4000 | Y |
| Butanone | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 160 | 80 | Y |
| Xylenes | 0.49 | 0.26 | 0.44 | 0.00 | 1.18 | 59.0 | 29.5 | Y |
| Napthalene | 0.23 | 0.12 | 0.21 | 0.00 | 0.56 | 14.0 | 7.0 | Y |
| Chlorobenzene | 0.10 | 0.05 | 0.09 | 0.00 | 0.24 | 6.3 | 3.2 | Y |
| Benzyl alcohol | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | NA | NA | N |

The concentrations of the individual four point sources were added together regardless of the location of the maximum impact or the meteorological conditions under which they occurred. This methodology was thought to provide a factor of safety and to assure than any chemical constituents screened would not have an adverse ambient air impact. Of the 14 chemicals under consideration in the screening analysis, 12 could have been dropped from further detailed consideration. The maximum 24-hour concentrations of the 12 chemicals were less than 50 percent of the applicable ambient impact level. The 50-percent criterion was selected on the basis of the typical factor two assigned to the accuracy of dispersion models. The chemical constituents that did not pass this screening test were included in the detailed analysis. As a final check on the screening results, the 12 chemicals that passed the analysis were maintained in the initial detailed modeling for comparison to the PTPLU concentration estimates (adjusted for 24-hour averaging).

Detailed Modeling Analysis

Model Selection

The dispersion model selected for detailed analysis of the 24-h ambient impacts was the short-term version of the Industrial Source Complex (ISCST) Model (EPA-450/4-86-005a, June 1986). The ISCST Model is recognized by the Guideline on Air Quality Models as a suitable model for complex sources and for fugitive emissions. In this analysis, the UNAMAP 6 version (the most recent version and currently available through NTIS or the National Computer Center in Research Triangle Park) was used for all estimates.

To accomodate the emission calculation procedure described in Section 5, the ISCST model was linked with the emission calculation programs in a separate program referred to as "AMBIENT". AMBIENT is basically a postprocessor adapted from EPA's TSDF model that allows the user to input unit emission rates to ISCST for subsequent prorating for actual rates.

The AMBIENT model was used to apply the calculated emissions from the facility to the ISCST receptor grid. Each treatment unit was assigned to an ISC source group that contained the stack data and emission rates for the applicable stack. AMBIENT also allows the user to input a pollutant-specific control efficency factor for each source. The ISCST run is made with source group emission rates as described later. Using actual meteorological data, expected impacts of the source groups are calculated for each receptor in $g/m^3$ and are shown in the next section.

Meteorological Data

Calculation of maximum 24-h concentrations was based on the use of five years of meteorological data. These data were obtained in hourly format from the National Weather Service office at Logan Airport (Station No. 14739) for the surface parameters, and from Portland, Maine (Station No. 14764) for the mixing height data. These data were processed together into the appropriate format for the ISCST Model. The ISCST model directly accessed these files during processing.

Receptors

The screening analysis indicated that the facility stacks have their maximum impacts at less than 300 m, and that the maximum impact might occur at or near the shoreline. To accommodate this possibility, receptors were placed along the shoreline as well as within another 100 m or so along the shoreline in potentially critical receptor locations as determined from screening analysis. Further review of the PTPLU results for other wind speed/stability class combinations indicated downwind distances of 500 m or less for maximum impact under some meteorological conditions. Maximum concentrations for ground-level area source emissions occur typically very near the sources. This fact, along with the screening analysis for the point sources, was sufficient justification for the placement of receptors for this more detailed modeling. Figure 10.6.7-2 presents the general layout of the selected receptor locations.

The screening model was used to guide receptor placement. Sixty-eight receptors were investigated. Of these 68 receptors, five were located in surrounding communities, including Point Shirley, Winthrop and Long Island. A larger, more complex grid of receptors was not deemed necessary in that the selected locations provided representative coverage of the maximum concentration locations, and any estimates made at these sites were conservative.

ISCST Unit Emission Results

Maximum concentrations were calculated for each source group included in the ISCST analysis using a unit emission rate for each of five years of meteorological data. As shown on Table 10.6.7-4, the maximum concentrations resulted from using 1985 meteorological data for all source groups except the PC-3 and 4 source group, which had a maximum resulting from the use of 1984 data. Because the primary treatment area, which is in ISCST source groups PC-1 and PC-2, has a greater emission rate than the secondary treatment area, the 1985 meteorological data were selected to represent the year with the greatest potential for a worst-case ambient impact. This data set was then used for the detailed analyses.

Table 10.6.7-5 presents additional detail on the results of calculations based on 1985 meterorology for 24-hour concentrations. This table presents the maximum calculated 24-hour concentration for each source group and identifies the location of the receptor where it had occurred. The critical days of analysis are also presented. These results as presented provide little insight into the pollutant-specific concentrations because no correction has been made for actual emissions on a source-by-source or pollutant-by-pollutant basis.

The results presented in Table 10.6.7-5 were used to provide detail on locations and the spatial distribution of the maximum impacts produced by the various source groups modeled. These locations are also given in Figure 10.6.7-3, which shows that the critical receptors were typically located at or near the shoreline of Deer Island. Because of the spatial distribution of sources over the property, the maximum impacts from individual sources were not expected to occur at colocated receptors. This is, in fact, the case as can be seen in the figure. The maximum concentrations due to the secondary clarifiers (AR-5 to 8) occurred at a nearby shoreline receptor to the northeast of the facility, as did that of the disinfection basin (AR-9) just southeast of the secondary clarifier impact point. The maximum combined

TABLE 10.6.7-4

MAXIMUM 24-HOUR NORMALIZED CONCENTRATIONS FOR EACH YEAR OF METEOROLOGICAL DATA ($ug/m^3$)

| Source Group No. | Meteorlological Year 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| PC-1, 2 | 5.6 | 5.7 | 5.5 | 7.9 | 9.3 |
| PC-1 | 6.2 | 6.3 | 5.7 | 6.1 | 8.6 |
| PC-3 | 10.3 | 9.4 | 9.2 | 11.8 | 12.2 |
| PC-3, 4 | 8.9 | 8.9 | 7.8 | 11.8 | 10.2 |
| AR-5 to 8 | 977,978 | 1,237,975 | 1,273,632 | 999,077 | 1,227,326 |
| AR-9 | 1,912,789 | 2,613,030 | 3,583,894 | 2,780,472 | 3,738,323 |

TABLE 10.6.7-5

UNIT EMISSION RESULTS OF ISCST ANALYSIS
USING 1985 DATA

| Source Group No. (ISCNO) | Description | Maximum Normalized 24-h Concentration, $\mu g/m^3$ | Critical Day | Coordinates, m X | Y |
|---|---|---|---|---|---|
| 1 (1,2) | PC-1, PC-2 | 9.3 | 130 | 339,300 | 4,690,500 |
| 2 (3) | PC-1 | 8.6 | 130 | 339,300 | 4,690,500 |
| 3 (4) | PC-3 | 12.2 | 37 | 338,800 | 4,689,690 |
| 4 (5,6) | PC-3, PC-4 | 10.2 | 223 | 339,200 | 4,690,700 |
| 5 (7-10) | clarifiers | 1,227,326 | 295 | 338,780 | 4,690,730 |
| 6 (11) | disinfection | 3,738,323 | 295 | 338,850 | 4,690,660 |

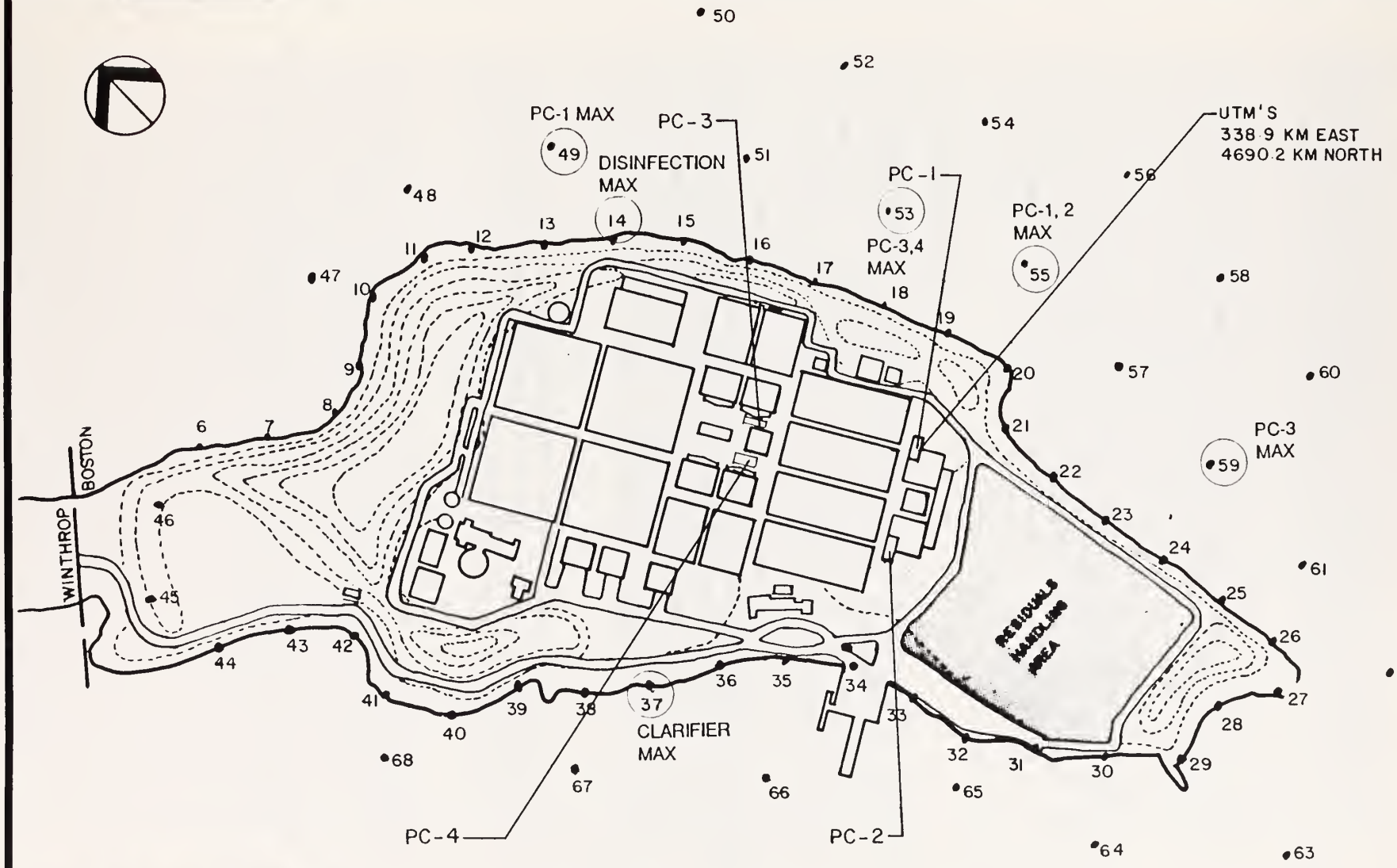


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**FIGURE 10.6.7-3**
**LOCATIONS OF IMPACTS FOR DEER ISLAND EMISSION SOURCES**

impact of the primary treatment system (PC-1 and 2) occurred about 300 m east of stack PC-1. Because the majority of the emissions from the proposed facility originate from the point sources (PC-1 to PC-4), the maximum combined impact of all Deer Island sources was expected to occur within 200 m or so around the eastern shoreline of Deer Island.

As a check on the critical receptor locations and days found in the ISCST Model analysis, a grid of receptors at 100 m intervals was placed around each critical receptor. For each critical day noted in Table 10.6.7-5, a separate ISCST Model analysis was performed to ascertain if the previously determined critical receptor was in fact located at the point of maximum expected impact. The detailed grid provided a sufficient selection of receptor locations to render such a finding. The results of this critical-day analysis showed that the critical receptor locations in the original ISCST Model analysis grid (Figure 10.6.7-3) were higher than any additional receptors in the detailed grid for the critical day analysis. Thus, the original selection of receptor locations was sufficient for finding the locations of maximum impacts.

Results of Detailed Analyses

The AMBIENT program was used to postprocess all ISCST Model results (1-hour concentrations for each source at each receptor for each hour of meteorological data) obtained using the 1985 meteorological data. The 1985 meteorological data were used for this analysis because they had been demonstrated to yield the highest ambient concentrations for the most important sources.

Table 10.6.7-6 presents a summary of the AMBIENT results on a 24-hour basis, along with a comparison to AALs or other critical impact level. These maximum ambient impacts are based on the emission rate produced from the minimum flow, maximum load scenario, and represent the worst case potential impacts from the facility on a short-term basis. The maximum unit emission concentrations from the ISCST Model analysis were used, although the temporal concurrence of worst-case emissions and dispersion meteorology may have a very low frequency of occurrence.

The comparison of maximum calculated ambient impacts to critical ambient levels indicates that the ambient impact of constituents present in the Deer Island influent and released from the treatment system will be much less than the critical levels even at the shoreline of Deer Island.

The conclusion of this ambient air quality impact assessment is that the proposed secondary treatment facility for Deer Island will have inconsequential impacts on the local population in terms of ambient air quality impacts. Proposed treatment system covers, controls, and processes will be operated in such a manner that even under a worst-case scenario the impacts will be within allowable air quality limitations accessible to the population at all locations. At the more easily accessible locations (neighborhood sites surrounding the facility), the impacts were found to be insignificant. The MWRA committments on odor control will be met.

TABLE 10.6.7-6

COMPARISON OF CRITICAL AND CALCULATED 24-HOUR CONCENTRATIONS FOR CONSTITUENTS RELEASED FROM THE PROPOSED DEER ISLAND TREATMENT FACILITY ($ug/m^3$)

| Constituent | Odor Threshold | Allowable Ambient Level | Worst-case 24-hour Concentration |
|---|---|---|---|
| Acetone | 240000 | 8000 | 0.08 |
| Benzene | 15000 | 4.0 | 0.07 |
| Benzyl alcohol | 24700 | NA[1] | 0.01 |
| Bromomethane | NA | 2.6 | 0.53 |
| 2-Butanone (MEK) | 29900 | 160 | 0.02 |
| 2-Butanone, 3-methoxy, 3-methyl | NA | NA | 0.10 |
| Carbon disulfide | 663 | 200 | 0.24 |
| Chlorobenzene | 980 | 6.3 | 0.18 |
| Chloroform | $10^6$ | 1.44 | 0.24 |
| o-Cresol | 1170 | 100 | <0.01 |
| p-Creso | 2.02 | 12.0 | <0.01 |
| 1,2-Dichlorobenzene | 24400 | 82.0 | 0.73 |
| Dimethyl disulfide | 5.0 | NA | <0.01 |
| Dimethyl sulfide | 2.57 | NA | 0.01 |
| Ethyl benzene | 615000 | 120 | 0.22 |
| Ethyl ether | 2550 | 160 | 0.33 |
| Hexone (MIBK) | 1950 | 280 | 0.40 |
| Methyl mercaptan | 4.19 | NA | 0.16 |
| Methylene chloride | 88000 | 8.0 | 1.1 |
| Naphthalene | NA | 14.0 | 0.41 |
| N-Nitrosodiphenylamine | NA | NA | <0.01 |
| Pentane, 2-meth, 2,4,4-trimethyl | NA | NA | 0.17 |
| Phenol | 195 | 52.0 | <0.01 |
| 2-Propanone, 1-flouro | NA | NA | 0.03 |
| Styrene | 639 | 39.0 | 0.30 |
| 1,1,2,2-Tetrachloroethane | 3480 | 1.2 | 0.49 |
| Tetrachloroethene | 34400 | 20.6 | 0.43 |
| Toluene | 649 | 51.0 | 0.55 |
| Trans-1,2-dichloroethylene | | 341 | 110 0.18 |
| 1,1,1-Trichloroethane | 553000 | 1300 | 0.52 |
| Trichloroethene | 272000 | 20.4 | 0.33 |
| Trichlorofluoromethane | NA | 762 | 0.20 |
| Xylene | 220 | 59.0 | 0.88 |

[1] No data available.

## 10.7 EVALUATION OF MAIN PUMPING STATION ALTERNATIVES

### 10.7.1 INTRODUCTION

The existing Main Pumping Station on Deer Island receives wastewater from two deep rock tunnels, each constructed 300 ft below sea level, and pumps the flow to the existing primary treatment plant on Deer Island. The Boston Main Drainage Tunnel has a maximum hydraulic capacity of 438 mgd and the North Metropolitan Relief Tunnel has a maximum hydraulic capacity of 350 mgd. The water surface in the existing primary treatment plant is at elevation 124 ft.

The Main Pumping Station currently houses nine wastewater pumps, each rated at 90 mgd at 99 ft total dynamic head (tdh). A tenth pump is being installed under the Fast-Track Improvement Program. There is room for only ten pumps in the Main Pumping Station. At the completion of the Fast-track Program, five pumps will be driven by 2,000-horsepower electric motors through eddy-current coupling drives. Each motor and drive is sized for a pump rated at 90 mgd at 99 ft tdh. The other five pumps will continue to be driven by the existing diesel engines.

To pump 438 mgd from the Boston Main Drainage Tunnel, it is necessary to operate five of the 90-mgd pumps, as well as four additional pumps, to pump 350 mgd from the North Metropolitan Relief Tunnel. With nine pumps required to operate during the peak flow, one pump is available for backup.

The design criteria for this facilities plan, presented in Section 4.0, calls for two backup pumps for every three operating pumps at peak flow. To meet this criterion, considering space is available in the Main Pumping Station for only ten pumps, it would require sizing the pumps so that only six operate at peak flow. To operate in this mode, three pumps take suction from the Boston Main Drainage Tunnel and three pumps would take suction from the North Metropolitan Relief Tunnel. The pump-sizing criteria would be based on the larger flow of 438 mgd requiring that each pump be rated at 146 mgd. However, at this flow, the velocity in the suction piping would be nearly 12 fps. Preferably, suction velocity should be limited to 6 fps. In practice, suction piping velocities under 8 fps have proved satisfactory, provided the flow is uniform and continually accelerates toward the pump.

The 60-in-diameter suction piping to each of the current pumps is cast in concrete and is inaccessible for modifications. This piping was originally designed for 90-mgd pumps. At 90 mgd, the suction velocity is 7 fps, which is already in the upper range of known acceptability. Also, the approach flow is not uniform due to the configuration of the suction manifolds. Installation of a pump larger than 90 mgd onto the existing suction piping can not be guaranteed acceptable. Therefore, for the purposes of facilities planning, ten pumps rated at 90 mgd each were selected. To provide additional redundancy, two additional pump units would be purchased and stored onsite.

However, because it is desirable to meet the redundancy criteria with installed capacity, it is recommended that larger capacity pumps be evaluated in more detail during the design phase. The largest size pump acceptable to the manufacturer, design engineer, and MWRA should be

selected since this would increase the installed redundancy. In examining the possibility of installing larger capacity pumps, two leading U.S. pump manufacturers were contacted. Both were concerned with the suction hydraulics. However, each manufacturer believed that they could provide a pump with a capacity higher than 90 mgd and would be willing to evaluate the problem in detail.

For the new wastewater treatment facilities at Deer Island, it will be necessary to convey the wastewater from the Boston Main Drainage Tunnel and the North Metropolitan Relief Tunnel to new grit removal facilities. The water surface elevation in the new grit chamber will be at 158 ft, which is 34 ft higher than the water surface elevation of the existing primary treatment basins. Consequently, the existing pumps in the Main Pumping Station will have insufficient head to pump the design flow to the new treatment facilities. All existing pumps, motors, variable-speed drives, and associated electrical and controls equipment must be replaced prior to start-up of the new treatment plant. Since all new mechanical and electrical pumping equipment will be required, alternative drives including eddy-current couplings and variable-frequency drives were considered.

Construction of a new pumping station to replace the existing Main Pumping Station was also considered, but was eliminated as a viable alternative for economic and technical reasons. Design criteria dictate that the new treatment plant be placed into service without shutting down the existing treatment process. If a new pumping station were constructed, it would not be practical to tie the new pumping station into the existing deep rock tunnels without stopping the flow. The existing Main Pumping Station includes isolation valves on the suction lines of the pumps. Therefore, if the existing station is utilized, each pump can be isolated and replaced individually without interrupting the operation of the other pumps. Also, modifying the existing pumping station would be substantially less costly than the construction of a new pumping station. Since the Main Pumping Station is structurally sound and can be expected to provide the required design life without replacement, a detailed comparison of a new, versus existing, pumping station was not performed.

### 10.7.2 EVALUATION OF ALTERNATIVES

To effectively handle the wide range of inflows to the Main Pumping Station, all ten pumps will be coupled to variable-speed electric drives. Two alternatives were considered to provide the required speed ranges: eddy-current couplings and variable-frequency drives. Both devices work in conjunction with a standard constant-speed electric motor to drive the pump.

Major modification or replacement of pumps, drive shafts, motors, piping, valves, and other items will be required. However, these changes are the same for both types of drives and are therefore not included as part of this evaluation of alternatives.

The eddy-current coupling would be installed between each pump and motor and is similar in appearance to the motor. It is in effect, a magnetic slip coupling. There will be no direct physical contact between the motor (or drive) side and the pump (or load) side of the coupling. With an eddy-current drive, the pump motor will operate at its normal constant speed, and

adjustment in pump speed will be achieved by increasing or decreasing the slippage at the coupling. The effect the coupling will have on the efficiency of the motor is equal to the speed ratio, as shown in Figure 10.7.2-1. The speed controller, which is a direct current power supply, and the motor starter for each pump, would be located in a cabinet adjacent to the motor. The system is air cooled. There is room available within the existing station to install all of the required equipment.

A variable-frequency drive varies the speed of the pump motor. The motor would be directly connected to the pump, and the speed adjusted by varying the frequency of the power input. All components of each drive are located in a single housing. The system is liquid cooled, and heat is rejected to the atmosphere thorough a liquid to air heat exchanger. The effect that the drive has on the efficiency of the motor is shown in Figure 10.7.2-1. There is insufficient space available in the station to house the variable-frequency drives, therefore, a new building would be required adjacent to the Main Pumping Station.

Cost estimates were prepared for each of the two pumping station alternatives. As presented in Table 10.7.2-1, present worth cost is the sum of all costs required to construct and operate the system, and is shown as an equivalent single initial investment. Project cost represents the estimated capital construction cost in September 1986 dollars, and includes a 35 percent allowance for engineering and contingency costs. Annual operation and maintenance cost is the average annual cost to operate and maintain the system, and includes the cost of power.

On the basis of lower cost, the preferred alternative is eddy-current couplings.

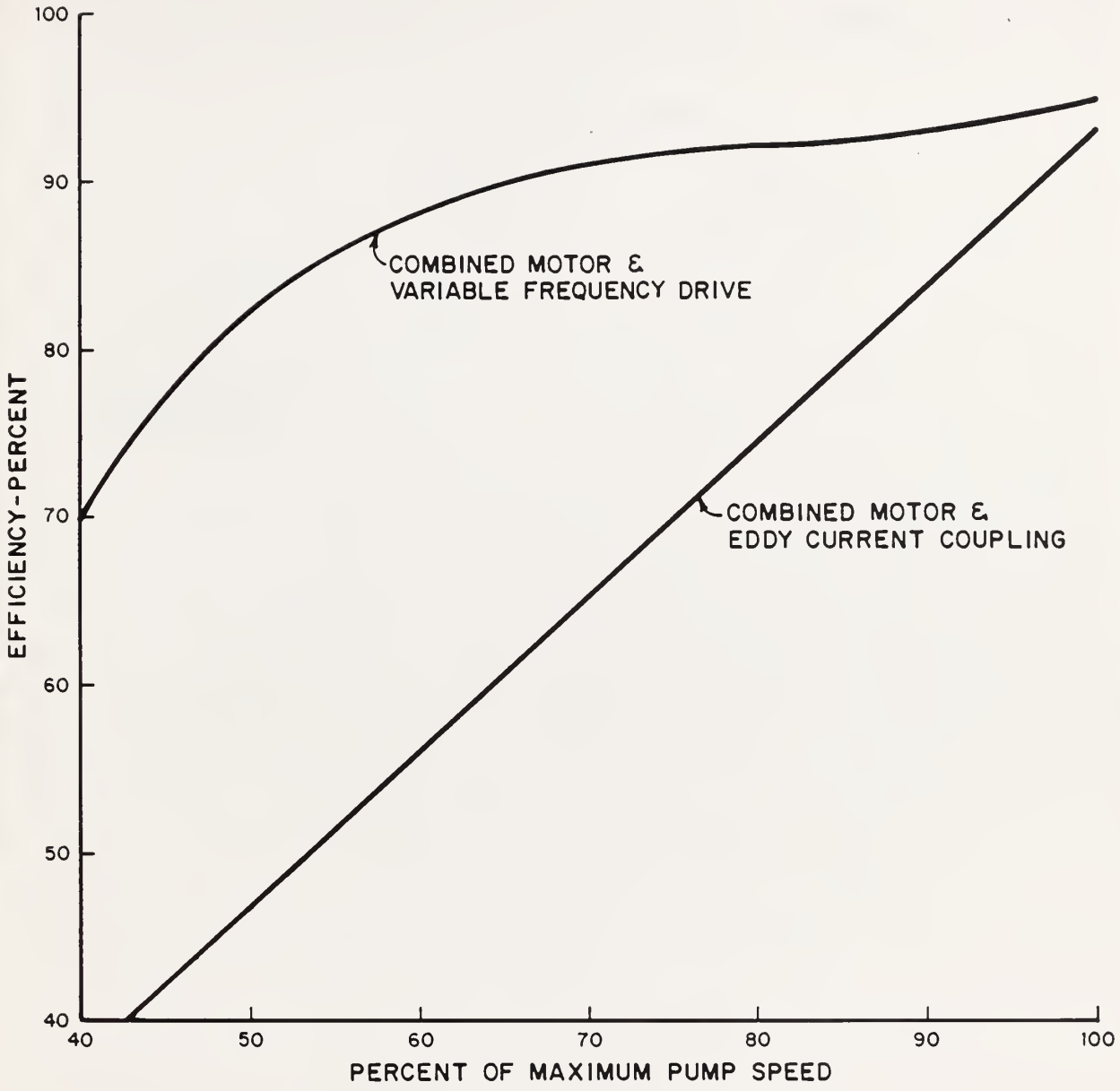


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FIGURE 10.7.2-1
VARIABLE SPEED DRIVE EFFICIENCY

TABLE 10.7.2-1

COST EVALUATION OF MAIN PUMPING STATION ALTERNATIVES

| | Cost in $ millions | |
|---|---|---|
| | Eddy-current coupling | Variable-frequency drives |
| Present worth costs | 43.4 | 49.2 |
| Project costs | 26.6 | 34.5 |
| Annual operation and maintenance costs | 3.3 | 3.0 |

# Section 11

# 11.0 RECOMMENDED PLAN

This section presents a description of all the recommended wastewater treatment facilities associated with the new Deer Island Wastewater Treatment Plant. Section 11.1 is a physical description of the treatment facilities including new headworks facilities, wastewater transport and pumping systems, and primary and secondary treatment facilities. This physical description includes all ancillary functions such as power, water, and other utilities, and support facilities such as the administration and maintenance buildings.

The physical description of other components of the wastewater treatment system, such as the inter-island conveyance system and the effluent outfall, are described in Volumes IV and V, respectively, of this Secondary Treatment Facilities Plan. Residuals processing and disposal facilities are described in the Residuals Management Facilities Plan.

Section 11.2 of this recommended plan discusses the construction considerations associated with the new wastewater treatment facilities. The two principal considerations are the maintenance of existing plant operation during construction of new facilities and the proposed division of construction activity into phases, and their respective schedules.

Section 11.3 presents estimates of capital and operating costs for the recommended plan.

Section 11.4 covers the environmental impacts of the recommended plan. It includes discussion of the impact of the plan on groundwater, air quality, land use and visual impacts, traffic, noise, terrestrial and aquatic ecology, and historical and archaeological resources. This information is required because this facilities plan serves as an environmental information report (EIR) for review under the Federal and State environmental review processes.

Section 11.5 discusses several institutional considerations pertinent to the wastewater treatment portion of the recommended plan. Volume VII of the Facilities Plan includes a more detailed discussion of other institutional considerations. The items discussed in this volume include the recommended operation and maintenance organization, training and staff development for operation of the recommended facilities, and a preliminary operations plan.

## 11.1 DESCRIPTION OF RECOMMENDED FACILITIES

The facilities recommended in this section are based on the screening-level evaluation discussed in Section 8, and the detailed site and process alternatives evaluated in Sections 9 and 10 of this Volume. The main portion of this section is a physical description of the recommended facilities. A summary of all unit process sizing and equipment is presented in Appendix J. Section 11.1.1 describes the North System Headworks Facilities, including the three existing remote headworks and the modified Winthrop Terminal facility. Section 11.1.2 discusses the new Nut Island Headworks. This headworks facility will replace the Nut Island Primary Treatment Plant. Wastewater from the South Metropolitan Sewer System will flow from

the new headworks facility through the inter-island conveyance system to the new South System Pumping Station at the Deer Island Plant.

Section 11.1.3 describes all facilities proposed for Deer Island. It includes a plan showing the horizontal and vertical configuration of the plant and a description of the wastewater treatment processes. The main wastewater treatment processes will include grit removal for the North System flows, primary treatment, secondary treatment, and disinfection. All wastewater is pumped to the influent of the plant. A new pumping station will be constructed for the South System flow. The existing Main Pumping Station and the Winthrop Terminal will be modified to pump the North System flow. The plant will include several air emission control facilities.

Plant utilities include a power plant and power distribution system, a potable and plant water system, basin dewatering and storm drainage systems, and communication, security and fire protection systems. The description of the Deer Island facilities includes discussion of the plant instrumentation and control strategy. Various ancillary facilities will be required including an administration, laboratory and operations management building, maintenance and storage building, and the four process control facilities. These four facilities will be located at the primary and secondary treatment facilities, at the main pumping/power plant complex, and at the Residuals Control Center (to be determined in the Residuals Management Facilities Plan). This section also describes the proposed landforms and landscaping plan for the island.

Section 11.1.4 discusses recommendations for further process pilot studies associated with the design of new secondary treatment facilities.

### 11.1.1 NORTH SYSTEM HEADWORKS FACILITIES

Wastewater flows from the North System will receive preliminary treatment at the existing Chelsea Creek, Columbus Park, and Ward Street remote headworks installations, and at the Winthrop Terminal headworks. The remote headworks will provide screening and grit removal before flows enter the Boston Main Drainage and the North Metropolitan Relief Tunnels. Flow to Winthrop Terminal will be screened before being pumped to new grit facilities at Deer Island.

#### Remote Headworks

Each of the remote headworks facilities has a similar layout and uses the same unit processes; however, the facilities have different capacities. The headworks facilities are presently being upgraded under the fast-track improvements program. At each of the headworks, new climber mechanical bar screens with 3/4-in bar spacing are being installed. In addition, equipment in the existing grit chambers and grit and screenings handling equipment is being replaced with similar equipment, and new ventilation and odor control systems are being installed. Based on the results of preliminary air sampling undertaken as part of the air and wastewater sampling program of this facilities plan, it does not appear that additional air emissions controls are required. However, once the fast-track improvements are complete, air

emissions monitoring should be conducted in accordance with DEQE protocol to verify this conclusion.

The improved remote headworks will adequately protect the inter-island conveyance system from grit deposition, and will protect the raw wastewater pumps at the North Main Pumping Station throughout the planning period. However, as evidenced by grit buildup at the existing Deer Island plant, additional grit removal will be required to protect the new treatment facilities. Additional grit removal for the North System flows would reduce the quantities of grit that could accumulate in the new treatment plant conduits, channels and basins and affect residuals handling facilities. This additional grit removal will be provided by new grit removal facilities on Deer Island, described later in this section. The anticipated grit and screenings quantities generated at each of the remote headworks are presented in Table 11.1.1-1.

Winthrop Terminal

The Winthrop Terminal Headworks presently screens floatable material and removes grit from the North Metropolitan Trunk Sewer flow before the wastewater is pumped to the existing primary treatment facilities or to the plant bypass. The fast-track improvements program will replace the existing bar screens with screens having a 7/8-in bar spacing, will upgrade the 6 wastewater pumps to maintain a firm capacity of 125 mgd, and will eliminate the plant bypass.

The recommended plan for the Winthrop Terminal facilities includes retaining the screens installed under the fast-track improvements program, replacing all wastewater pumps to increase the discharge head, and abandoning the existing Winthrop Terminal grit facilities. Grit removal for Winthrop Terminal flows will be provided at the new North System grit removal facilities on Deer Island. The pumps added under the fast-track improvements program will be replaced with 6 new pumps, each having a capacity of 32 mgd when pumping at the maximum total dynamic head (tdh) of 80 ft. The pumps will have 600 hp electric motors and variable speed drives. The pumps require replacement because the new Deer Island grit removal facilities will be vertically placed at an elevation of 158 ft, which is approximately 30 ft higher than the existing Winthrop Terminal grit removal facilities. The estimated screening quantities generated at Winthrop Terminal are given in Table 11.1.1-1. Air emissions control facilities are not being installed at Winthrop Terminal under the fast-track improvements program. However, it is recommended that the ventilation air from the Winthrop Terminal be treated at the adjacent air emissions control facility recommended as part of this facilities plan. This facility has the capacity to treat 15,300 scfm of air from the Winthrop Terminal, plus low air flows from the venting of the shafts for the Boston Main Drainage and North Metropolitan Relief tunnels. The air emissions control system is discussed in further detail in Section 11.1.3.

## 11.1.2 DESCRIPTION OF NUT ISLAND SITE LAYOUT AND FACILITIES

Wastewater flow from the South System will receive preliminary treatment at new headworks facilities on Nut Island. It will then be transported through the new inter-island conveyance system to Deer Island for further treatment. The recommended location for the new Nut Island

**TABLE 11.1.1-1**
**NORTH SYSTEM HEADWORKS**
**ESTIMATED GRIT AND SCREENING QUANTITIES**

| FACILITY | Average Grit Volume ($yd^3/d$) | Maximum Grit Volume ($yd^3/d$) | Average Screening Volume ($yd^3/d$) | Maximum Screening Volume ($yd^3/d$) |
|---|---|---|---|---|
| Chelsea Creek | 2 to 3 | 6 to 9 | 4 to 6 | 13 to 19 |
| Columbus Park | 0.5 to 1 | 2 to 3 | 2 to 3 | 5 to 8 |
| Wark Street | 1.5 to 2 | 4 to 6 | 4 to 5 | 11 to 16 |
| Winthrop Terminal | --- | --- | 1.5 | 1.5 |

headworks facility is the site presently occupied by the existing Nut Island treatment plant's anaerobic digesters.

Site Plan

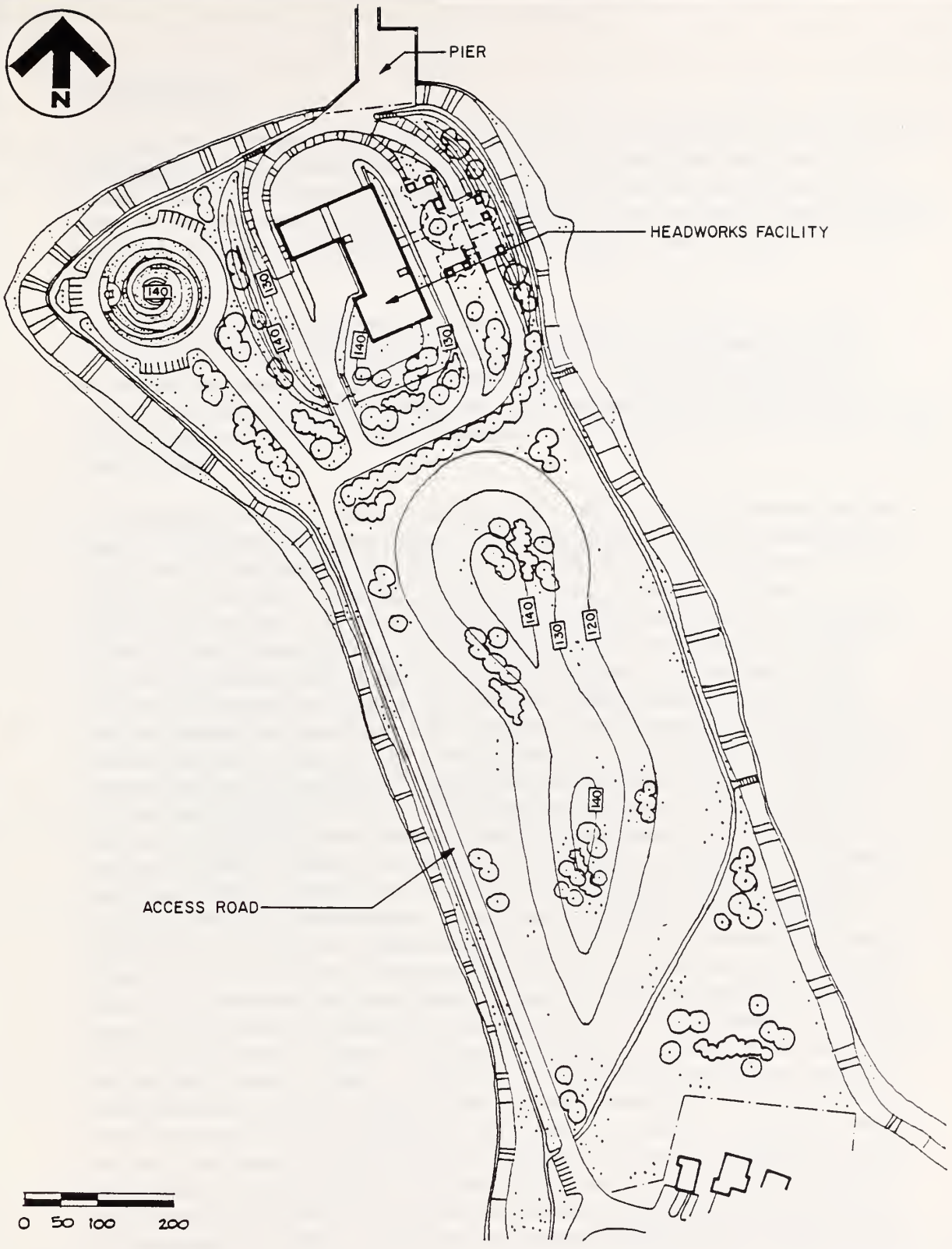
The headworks facility consists of a hydraulic transition section, a screening building, and grit removal facilities. The existing grade at the selected site is approximately 131 ft, while the final grade at the site will be approximately 128 ft. The hydraulic transition section, connecting the headworks facility to the High Level Sewer, is located below grade. The most visible component of the facility is the headworks building which houses the screening facilities, truck loading bays, air emissions facilities, administrative, operation, employee and maintenance areas. This building covers approximately 19,000 $ft^2$ and is 20 ft high. Adjacent to the headworks building are the grit chambers, located below grade, covering an overall area of approximately 22,000 $ft^2$. The inter-island conduit shaft is located to the south of the grit chambers.

Transportation Access to the headworks facility is by either the existing main access road along the western side of the island, or the pier to be constructed at the northeast end of the island. The main road would be used by headworks facility employees, facility visitors and recreational visitors to the island. Trucks transporting grit and screenings off the island, or odor control chemicals to the island, would use either the main road or the piers. The roadways on the island are arranged to provide safe traffic patterns for all vehicles, and allow fluid movement of the trucks serving the headworks facility.

Site Development The site plan for Nut Island allows for safe, shared use for wastewater treatment and passive recreation. Areas designated for wastewater treatment facilities are separated from the remainder of the island by fences and earth berms, for purposes of public safety and security.

The portions of the site that have not been designated for wastewater treatment purposes are planned as open space for passive recreation. This concept is consistent with the City of Quincy's land use zoning classification for Nut Island as "open space". Landforms and vegetation on the island promote passive recreational uses. A pedestrian path encircles the island, providing continuous viewing points of Boston Harbor and Quincy and Hingham Bays and convenient access to most of the island including the beach on the eastern shore.

Proposed landscaping on the island is designed to be functional, while at the same time creating a natural visual image. Earth berms up to elevation 140 ft are formed around and against the wall of the screening building and grit chambers. The berms, trees and shrubs are arranged to visually screen the headworks facilities primarily from Hough's Neck, but also from across Quincy Bay and the pedestrian path encircling the island. Land forms are placed in the center of the island and at the northwest corner of the island to provide additional visual screening and harbor viewing areas. An architectural representation of the developed Nut Island site is presented in Figure 11.1.2-1.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.1.2-1**
**NUT ISLAND SITE PLAN**

Headworks Facility

The recommended headworks facility receives flow from the existing High Level Sewer through an inlet hydraulic transition section, then screens the flow to remove rags and trash that may hamper operation of downstream treatment equipment. The facility then removes grit that may cause wear on downstream moving mechanical equipment, or that may collect in conduits, channels and basins. Plan and sectional views of the headworks facility are shown in Figures 11.1.2-2, 11.1.2-3, and 11.1.2-4.

The main function of the 190-ft-long hydraulic transition section, which connects the High Level Sewer to the headworks facility, is to distribute flow evenly to the screens throughout the expected flow range. The transition section is shaped to minimize the deposition of grit at low flow conditions. Also, the transition section is configured so that the High Level Sewer's maximum hydraulic capacity of 360 mgd will not be restricted by normal operation of the headworks facility.

Four wastewater screens are located in the headworks building. Two of the screens have the capacity to handle the peak flow of 360 mgd. The remaining two screens are on standby. The screens have a 3/4-in bar spacing with a climber cleaning mechanism. The screens, set at an angle of $80^{\circ}$ to horizontal, would be placed in 11.5 ft by 11.5 ft channels that are approximately 40 ft long. Operation of the climber raking mechanism would be automatically actuated by either a timer or a pressure differential sensor that senses a headloss across the bar screen. Screenings removed from the bar screens discharge to a cross-conveyor that transports the screenings to one of the three residuals transport conveyors. The conveyors raise and transport the screenings to truck loading bays. The headworks building has three residuals transport conveyors, each of which can move grit or screenings, or combined loads. The conveyors have the capability of discharging to any one of three containers located in individual truck loading bays. Three truck loading bays have been provided to allow for the flexibility to separate the grit and screenings into individual containers, plus maintain an additional container on standby. All conveyors, including the cross-conveyor, are inclined to some degree to allow positive draining of water from the residuals being transported. The anticipated residuals volumes generated on an average annual basis are 11 $yd^3$ per day of screenings and 11 $yd^3$ of grit. Using a peaking factor of 3.0 for grit volumes and screening volumes, up to 33 $yd^3$ per day of screenings and up to 33 $yd^3$ per day of grit may have to be handled. The wastewater flow, after passing through the screens, is collected in a common channel and transported to centrifugal grit removal chambers. Six grit chambers are provided, each having a capacity of 72 mgd. At the peak flow of 360 mgd, 5 chambers are required, with the remaining chamber on standby. Settled grit is periodically pumped from the chambers to grit separating and classifying equipment located in the screening area. Two 150 gpm vortex pumps are provided for each grit chamber, one of which is on standby. A total of 12 pumps is provided. The pumps discharge to a parallel piping header system that is configured to allow maintenance of any pipe segment without disrupting grit removal. After removal from the chamber, the grit is concentrated in cyclone grit separators and washed of organic material in inclined screw grit classifiers. Throughout the anticipated operating range, the pumps from

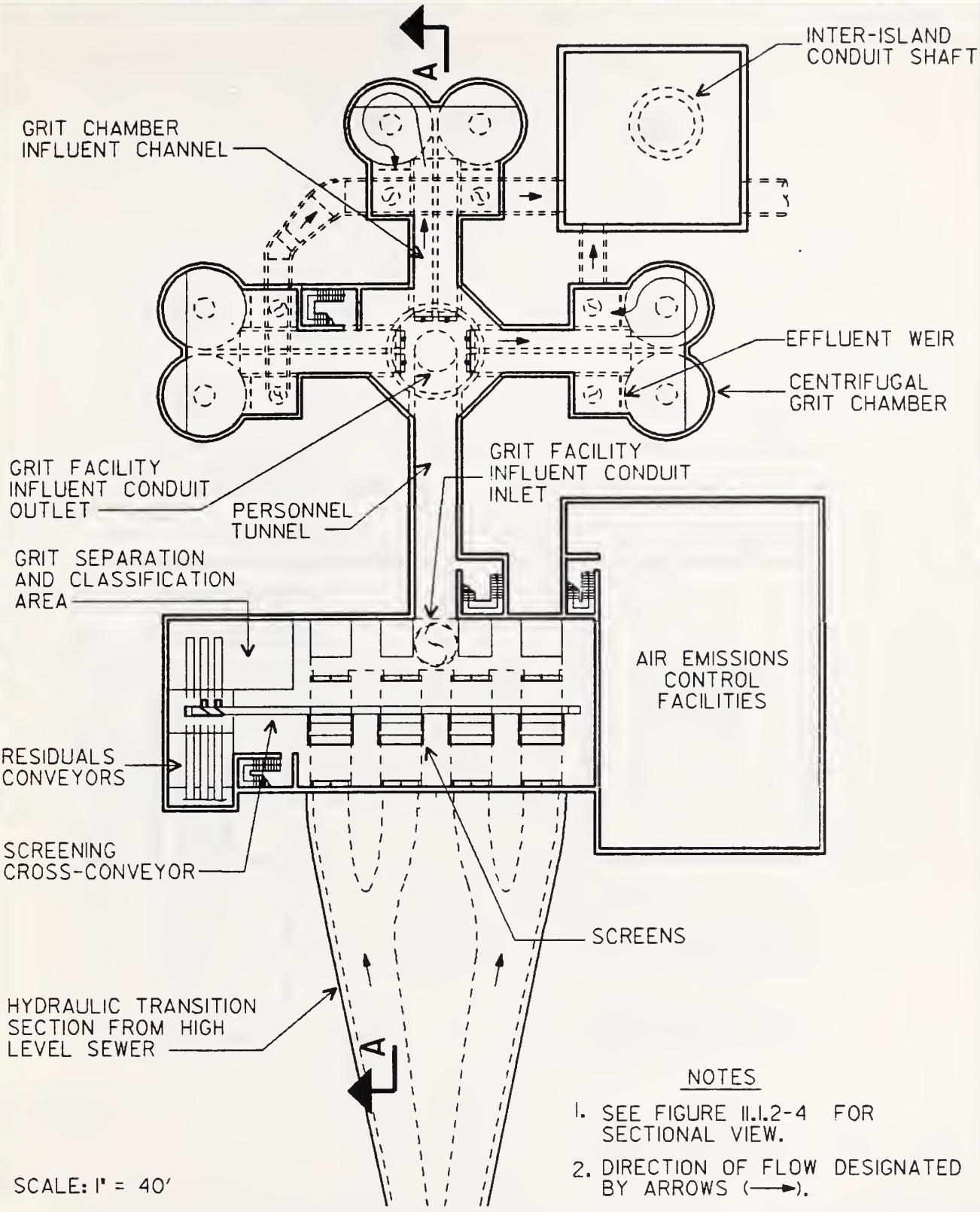



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**FIGURE 11.1.2-2**
**NUT ISLAND HEADWORKS FACILITY**
**PLAN AT ELEVATION 116**

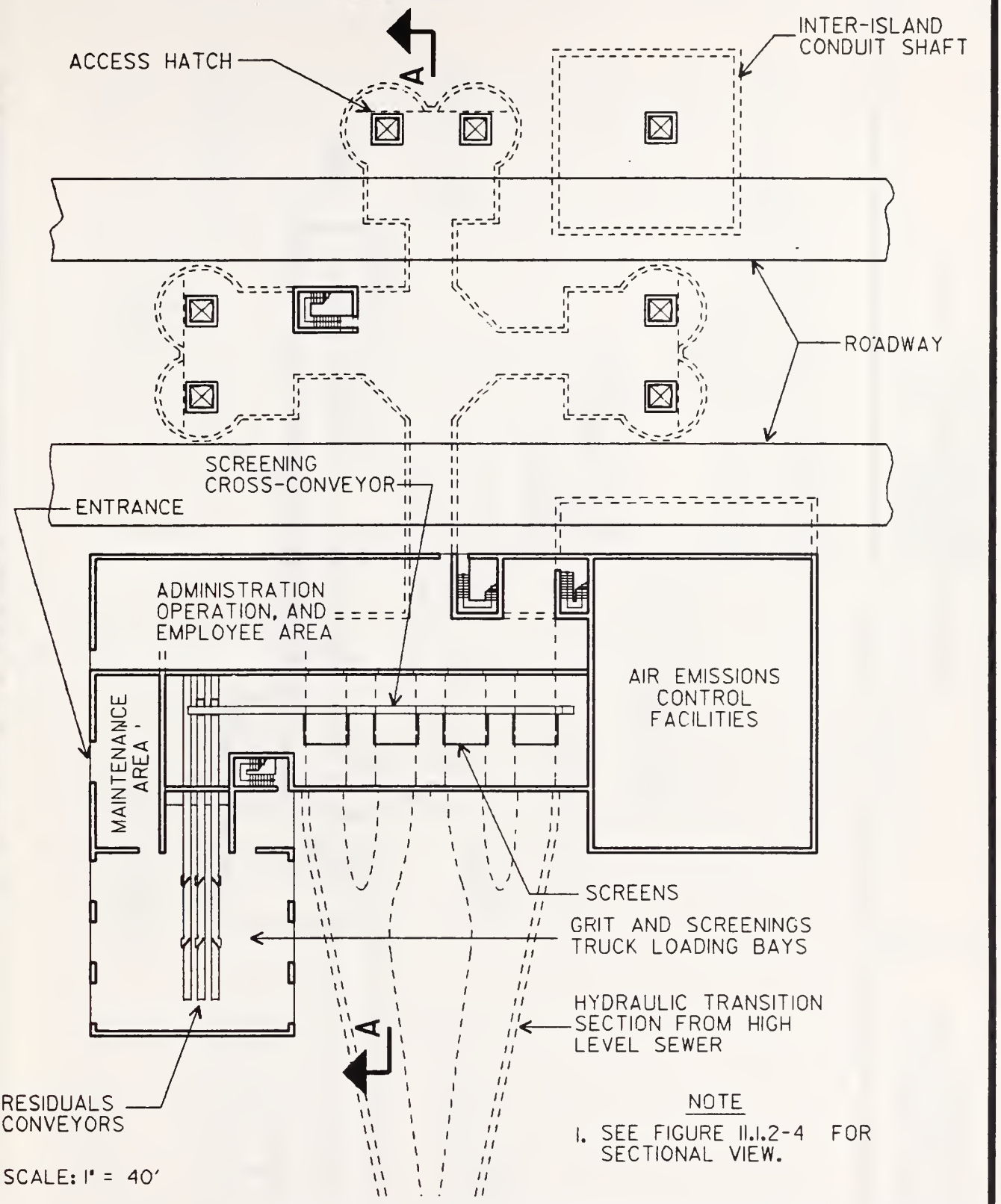


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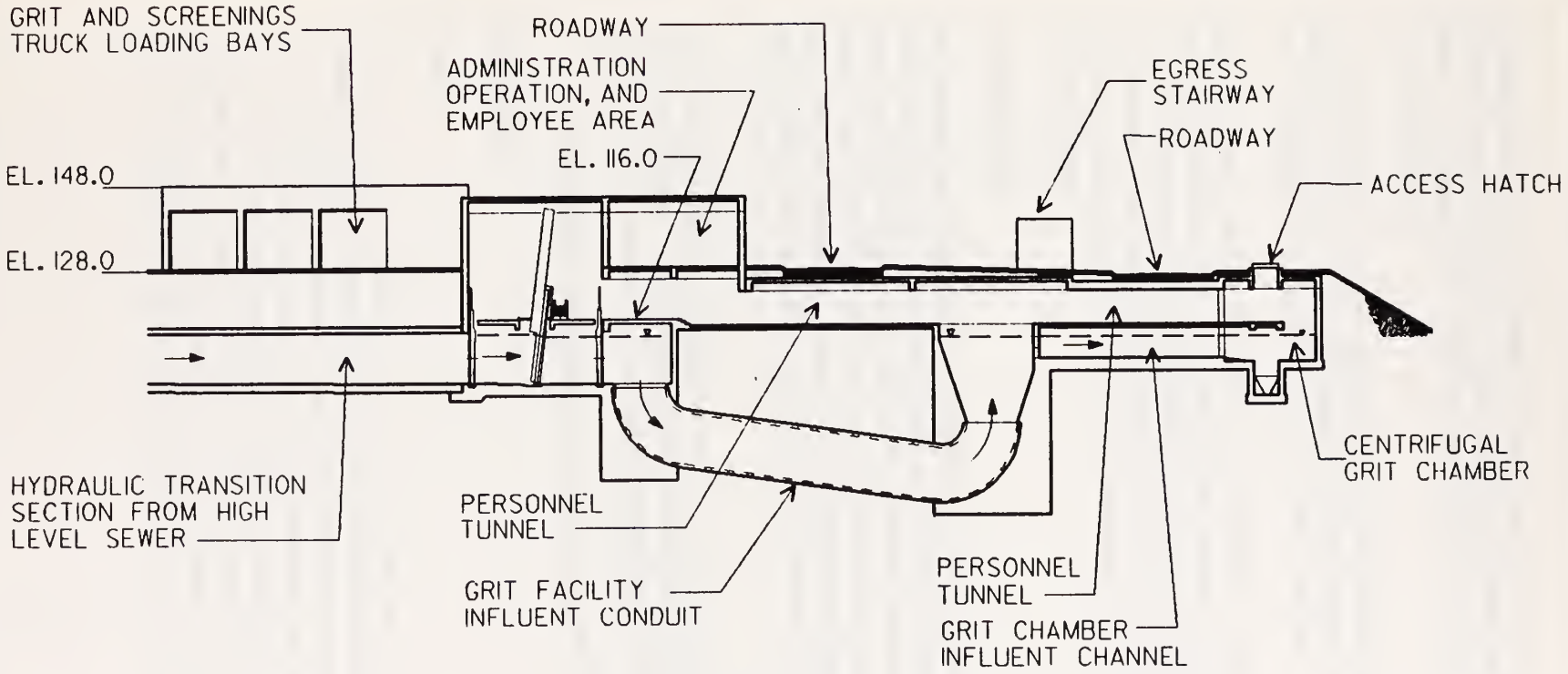
**FIGURE 11.1.2-3**
**NUT ISLAND HEADWORKS FACILITY**
**PLAN AT ELEVATION 128**




## SECTION A-A

SCALE: 1" = 40'

NOTES

1. SEE FIGURES 11.1.2-2 AND 11.1.2-3 FOR PLAN VIEWS OF THE HEADWORKS FACILITY.
2. DIRECTION OF FLOW DESIGNATED BY ARROWS (⟶).

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.1.2-4**
**NUT ISLAND HEADWORKS FACILITY**
**SECTIONAL VIEW**

two adjacent grit chambers discharge to one cyclone and classifier. Up to three 3 cyclones and classifiers are needed at one time, with 2 additional cyclones and classifiers provided as standby. The separated and washed grit is discharged to an inclined conveyor for transport to the truck loading bays.

The grit chambers are covered and the screens are enclosed in the headworks building to allow control of air emissions. The peak capacity of the air emissions system is 55,000 scfm. Air emissions facilities are discussed further later in this subsection.

Personnel access to the grit chambers from the headworks building is through a system of tunnels located directly over the chamber influent channels. A hatch to the outdoors is provided directly above each of the chambers, allowing for movement of equipment in and out of the chambers. Also, an egress stairway from the grit removal area is provided for safety purposes. The tunnel system connects to the inter-island conduit shaft located just south of the grit chambers.

Hydraulic Profile

The hydraulic profile and the vertical placement of the Nut Island Headworks Facility is influenced by the High Level Sewer hydraulic operating conditions. The capacity of the High Level Sewer of 360 mgd is dependent on a free flowing water surface elevation of 114.3 ft. Using the sewer elevation 114.3 ft as the design basis, the hydraulic profile across the facility has been established. Figure 11.1.2-5 presents the hydraulic profile for the expected range of flows. The maximum water surface drop between the inlet of the bar screen channel and the grit effluent weir is about 1.1 ft.

From the grit chambers the wastewater flows to the 16-ft inside diameter vertical shaft of the inter-island conduit. The operating water surface elevation in the shaft varies between 102 and 107 ft and is controlled by the proposed South System Pumping Station on Deer Island.

## 11.1.3 DESCRIPTION OF DEER ISLAND RECOMMENDED SITE LAYOUT AND FACILITIES

Plant Layout

General

The Deer Island site plan consists of four interrelated parts - the buffering landforms, the treatment facilities, the support facilities, and the residual management facilities. The parts are tied together by an external access system consisting of roadways, piers, and service roads and an internal access system consisting of passageways, pipe galleries, and stairwells. Each of the parts has its own distinct visual image - the landforms are gently sloped earthen and vegetated hills, the support facilities are multistoried red brick faced buildings, and the treatment facilities are large massings of concrete basins. (The residual management facilities will be the subject of the RMFP.) These parts have been assembled so that the concrete

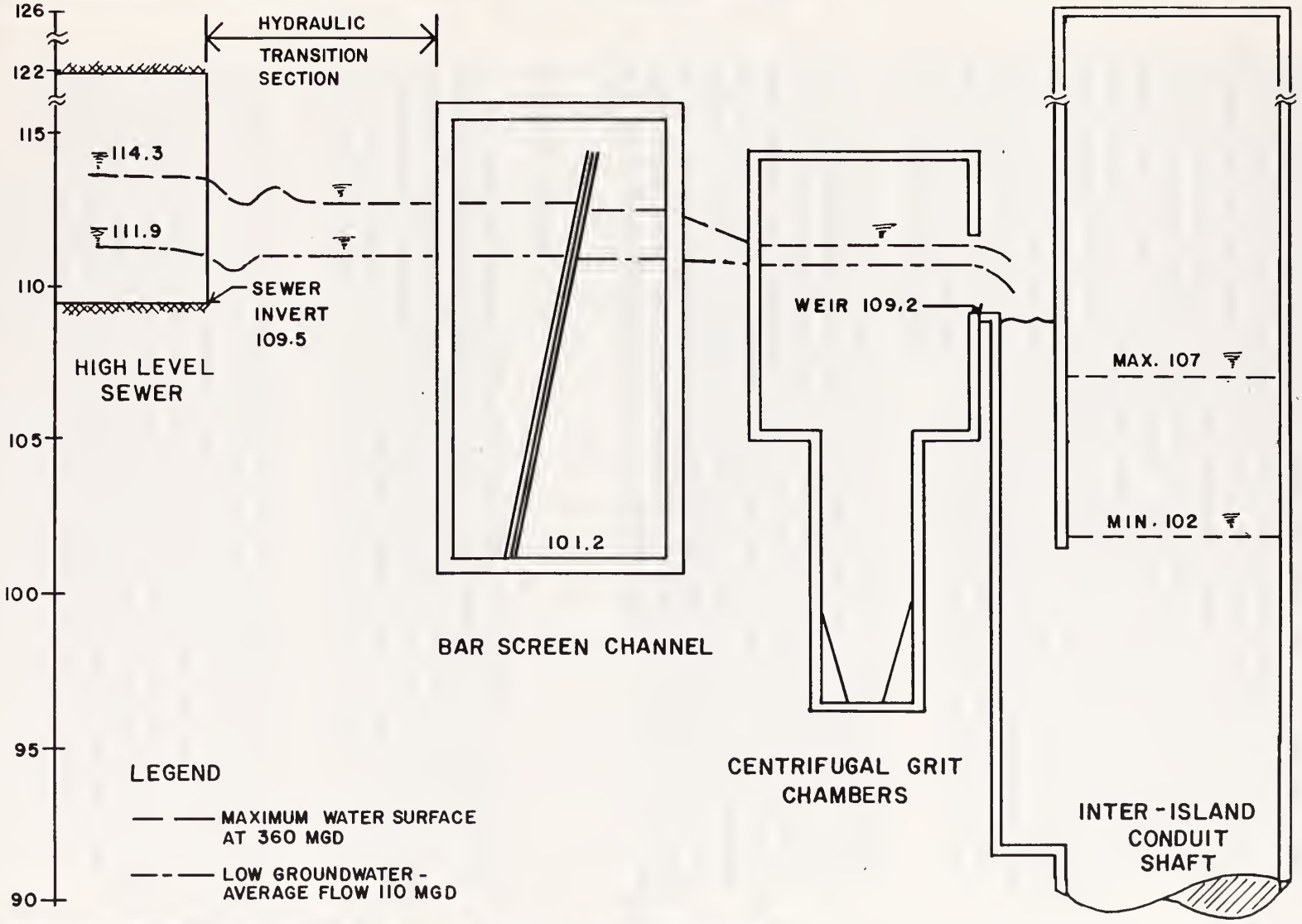



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FIGURE 11.1.2-5
NUT ISLAND HYDRAULIC PROFILE

treatment facilities occupy the central portion of the site, the brick faced support facilities occupy the adjacent area on the western, southern and eastern side of the treatment facility, and the landforms occupy the outermost portion of the site and effectively conceal the treatment facilities and support facilities on the northern, eastern and western sides of the site. The appearance of the recommended facilities to a viewer will depend upon the viewer's location. Within the landform areas on the outer edge of the site, the visual image will generally be of the earthen vegetated hillsides. This image will also be seen by distant viewers, particularly those to the north and east of the site. The view from the external access roadway located between the western landforms and the treatment facilities will be of the brick faced support facilities backdropped by the concrete walls of the basins, with earth landforms rising around the horizon. From the treatment facilities, the view will consist of a large expanse of covered and uncovered basins surrounded by support buildings which are backdropped by the earthen landforms. The impression made on a visitor to the site would therefore be that of a progression from a natural to a technological environment, as the visitor proceeds into the facilities.

Vertically, the design of the site is organized around two distinct zones. The lower/access zone is at approximate elevation 120 to 130 ft, and is the level at which the piers, access roadways, internal passageways, and the ground floor of the support buildings are located. The upper/facilities zone at elevations 145 to 155 ft is the level at which the tops of basins, air emission control facilities, operation buildings, and service roadways are located. Within the facilities, air emission exhaust stacks, potable water storage tank, oxygen plant distillation columns, and power plant exhaust stacks create vertical spikes rising to elevations between approximately 200 and 230 ft. Around the facilities the landforms rise to elevations ranging from approximately 180 to 220 ft and are connected by ridges with elevations of approximately 150 ft.

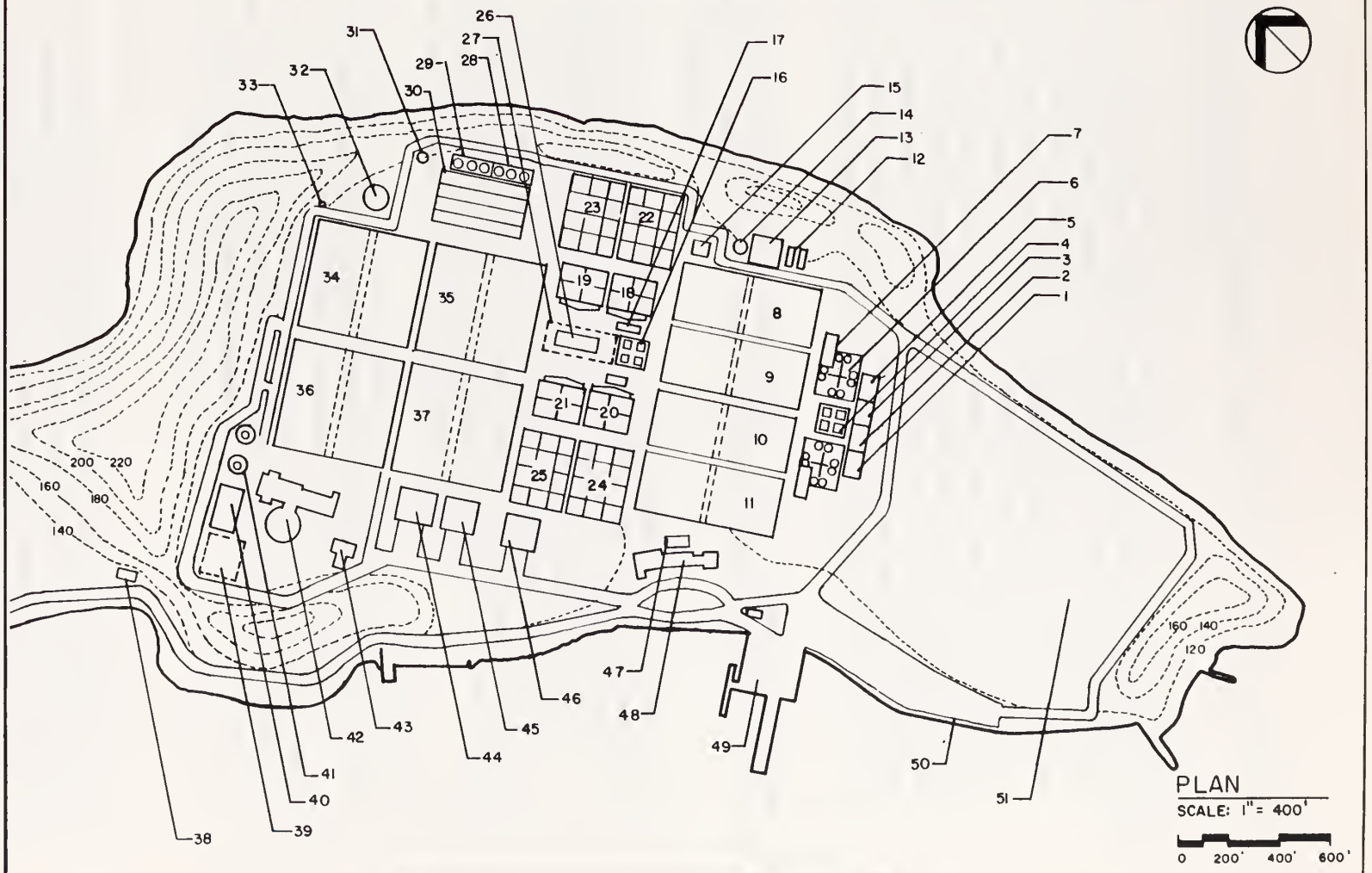
Treatment Facilities

The recommended treatment facilities for Deer Island provide primary treatment followed by secondary treatment. The secondary treatment process consists of oxygen activated sludge treatment with an anaerobic selector basin preceding the oxygen aeration basins. The recommendation incorporates the use of stacked rectangular primary and secondary clarifiers. The site layout incorporating the recommended facilities is shown in plan view at a scale of 1 in = 400 ft on Figure 11.1.3-1 at the end of this volume, and at a scale of 1 in = 600 ft on Figure 11.1.3-2.

The main process area of the liquid treatment facilities is aligned in a rectangular grid on a generally south to north axis, extending from approximately the southern edge of the existing drumlin and proceeding northward to the area currently occupied by the Hill Prison structure. The southerly portion of the main process area consists of primary treatment facilities, the central portion is dedicated to the anaerobic selector basins and the aeration basins, and the northern end consists of the secondary clarifiers. The plant is subdivided within each of the primary and secondary treatment areas into four equal sized batteries, with each of the batteries containing multiple basins. Residuals handling facilities (per the Residuals

LEGEND

1. GRIT HANDLING
2. PRIMARY OPERATIONS BUILDING
3. SOUTH SYSTEM PUMPING STATION
4. PRIMARY SPLITTER BOX
5. ELECTRICAL/MECHANICAL ROOMS
6. GRIT FACILITY (TYP OF 2)
7. PRIMARY ODOR CONTROL (TYP OF 2)
8. PRIMARY CLARIFIER BATTERY A
9. PRIMARY CLARIFIER BATTERY B
10. PRIMARY CLARIFIER BATTERY C
11. PRIMARY CLARIFIER BATTERY D
12. CRYOGENIC FACILITY (TYP OF 2)
13. COMPRESSOR BUILDING
14. LIQUID OXYGEN STORAGE
15. PRIMARY SCREENING
16. SECONDARY SPLITTER BOX
17. SECONDARY ODOR CONTROL (TYP OF 2)
18. ANAEROBIC SELECTOR BASIN A
19. ANAEROBIC SELECTOR BASIN B
20. ANAEROBIC SELECTOR BASIN C
21. ANAEROBIC SELECTOR BASIN D
22. AERATION BASIN BATTERY A
23. AERATION BASIN BATTERY B
24. AERATION BASIN BATTERY C
25. AERATION BASIN BATTERY D
26. SECONDARY OPERATIONS BUILDING
27. SECONDARY SLUDGE PUMP STATIONS
28. SODIUM HYPOCHLORITE STORAGE
29. SODIUM METABISULFIDE STORAGE
30. DISINFECTION BASINS
31. OUTFALL SHAFT
32. POTABLE WATER TANK
33. CEMETERY MARKER
34. SECONDARY CLARIFIER BATTERY A
35. SECONDARY CLARIFIER BATTERY B
36. SECONDARY CLARIFIER BATTERY C
37. SECONDARY CLARIFIER BATTERY D
38. GATE HOUSE
39. ELECTRICAL SUBSTATIONS
40. POWER FACILITIES
41. DIESEL STORAGE ( TYP OF 2 )
42. NORTH MAIN PUMPING STATION
43. WINTHROP TERMINAL
44. DRY STORAGE
45. VEHICLE MAINTENANCE
46. MAINTENANCE/WAREHOUSE
47. LABORATORY
48. ADMINISTRATION BUILDING
49. PIERS
50. BULKHEAD DOCKS
51. RESIDUAL PROCESSING




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.1.3-2**
**RECOMMENDED DEER ISLAND FACILITIES**

Management Faciities Plan) will be located in the area between the liquid treatment facilities and the southern tip of the island.

The extreme southern end of the liquid treatment facilities consists of a massing of buildings which include a pumping station to lift the South System flows from the inter-island conveyance system, centrifugal degritting facilities for North System flows, and a flow splitter structure to divide the flow between the four primary clarifier batteries. In the central portion of the plant is another flow splitter structure that receives the effluent from the primary batteries and divides the flow among the four batteries of anaerobic selector basins. Each selector battery then directly feeds a battery of aeration basins. Each of the aeration basin batteries feeds a battery of stacked secondary clarifiers. Effluent from the secondary clarifiers will be conveyed to chlorine contact basins for disinfection and will, if necessary, be dechlorinated. (Should environmental testing indicate that dechlorination is not required, then disinfection contact time could be provided within the outfall pipeline, eliminating the chlorine contact basins.)

The schematic of the process flow is shown in Figure 11.1.3-3. The process flow schematic does not include flow streams (grit, scum, primary sludge, waste activated sludge) associated with residuals management.

Covers will be constructed atop the primary sedimentation tanks, to control emissions. The anaerobic selector and aeration basins will also be covered. The ductwork to connect these units to the buildings housing air emission control facilities will be located above the covers. The grit removal facilities and splitter boxes will also be fully covered and these structures will be directly ventilated to the emission control facilities. Air emission control facilities are also provided for the South System Pumping Station wet well, the screened primary effluent channel, the North Main Pumping Station tunnel shaft, Winthrop Terminal, and the secondary clarifiers' aerated influent channels.

The hydraulic profile, under peak flow conditions, begins at elevation 158 ft at the North System grit removal facilities and drops approximately 20 ft across the plant to an elevation of 138.5 ft at the chlorine contact basin effluent weirs. The resulting elevations of the process facilities, together with the recommended construction of new landforms, results in the treatment facilities presenting, within the internal zone of the plant, a 25-ft to 40-ft-high exposed profile on both the western and southern elevations. The northern and eastern elevations will be bermed into the new landforms.

Support Facilities

The support facilities have been located along the western, southern and eastern side of the plant as independent, brick faced structures with either connecting tunnels, passageways, or bridges to the main treatment structure. The majority of the support facilities including the power facilities, North Main Pumping Station, maintenance, warehousing, administration and

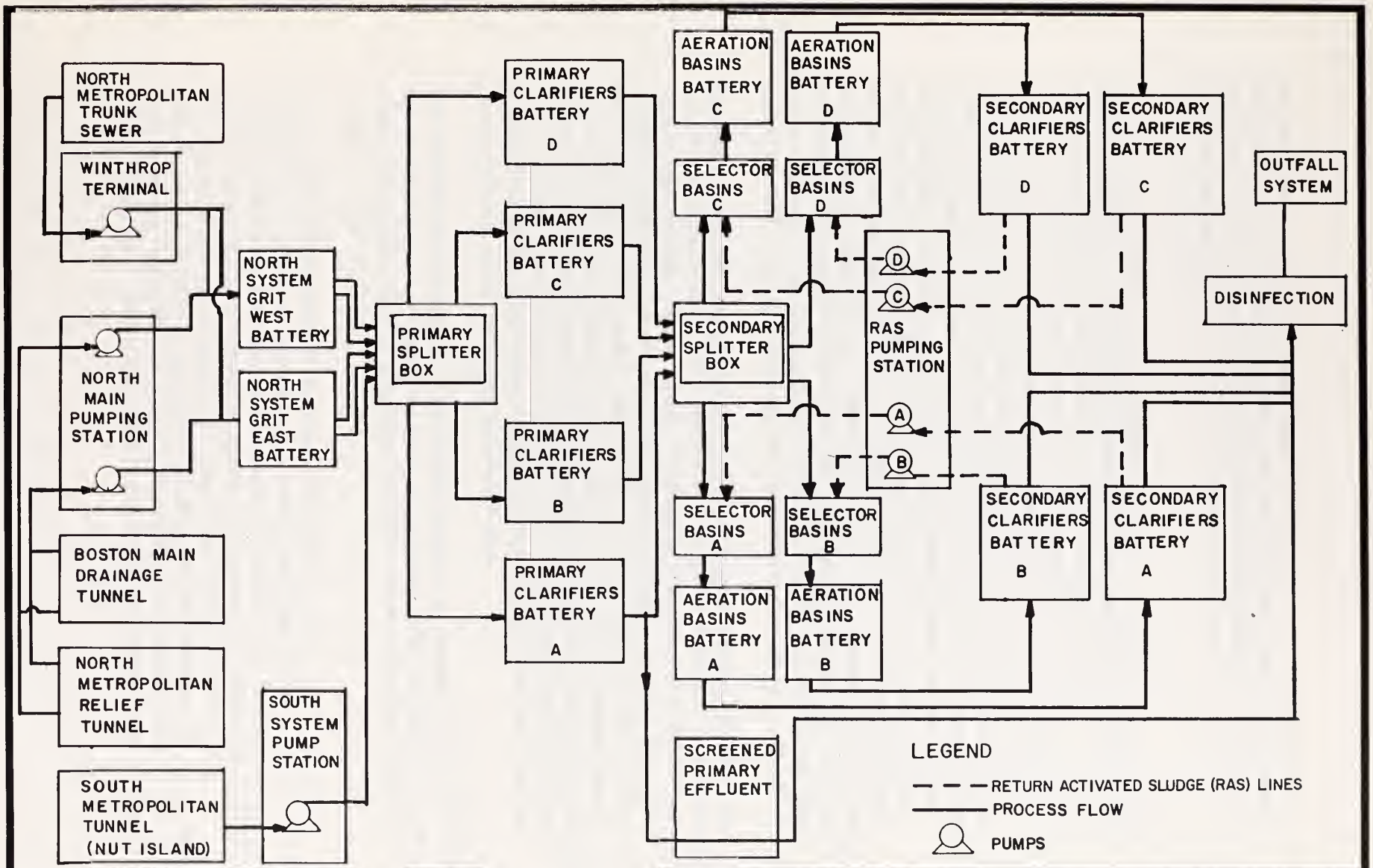



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**FIGURE 11.1.3-3**
**FLOW SCHEMATIC OF WASTEWATER TREATMENT PROCESS**

laboratory operations have been located along the western side of the treatment facilities. On the southern side of the treatment facilities have been located the primary facilities control center, the grit handling facilities, and the South System Pumping Station. On the eastern side of the treatment facilities are located the oxygen generation plant and the primary effluent screening structure.

Support Facilities on Western Edge of Treatment Facilities. The administrative facility and operations management center have been located within the Administration Building which incorporates the old steam pumping station structure at a location convenient to the pier. A new two story wing will be added to the back of the old steam pumping station to house the laboratory facilities and provide a connecting passage linking the new wing to the access zone of the treatment facilities. Both the existing North Main Pumping Station and Winthrop Terminal buildings are to be retained and utilized for pumping the North System influent to the new North System grit facilities. An addition to the Winthrop Terminal will house air emission control facilities. New maintenance facilities will be located between the main pumping station and the administration facility. The maintenance facilities will consist of a spare parts warehouse and plant maintenance facilities, a plant vehicle maintenance and storage garage, and a dry storage facility for oversized spare parts. The maintenance facilities will be connected via passageways to the access zone of the treatment facilities. To the immediate north of the existing main pumping station a switchyard area for the two main power feed transformers and a building to house the power generation facility have been located.

Operations Centers and Support Facilities on Southern Edge of Treatment Facilities. The operations management center which monitors all of the plant's functions is located within the Administration Building. Within the liquid treatment facilities there are two control centers, one for the primary facilities and one for the secondary facilities. Located to the south of the main process area is a complex referred to as the Primary Complex, which is made up of separate buildings, each housing independent preliminary and primary treatment-related functions. The complex includes the primary treatment control center, the South System Pumping Station, the Deer Island Grit Removal Facility, the Deer Island grit handling facility, the East and West Air Emissions Control Facilities, the Primary Splitter Box, and a building housing electrical, HVAC, and a local maintenance shop.

The horizontal and vertical layout of the Primary Complex is configured to allow for efficient vertical and horizontal movement of personnel and equipment within the facility and to other areas of the treatment plant. An axonometric view of the Primary Operations Complex is presented in Figure 11.1.3-4.

The primary treatment control center contains an operations control room for the primary clarifiers, North System grit removal system, South System Pumping Station, primary effluent screening facilities and the two primary treatment air emission control facilities. A lunch room and locker rooms are provided for operators and maintenance staff assigned to the center. The shift supervisors will be located at the primary treatment control center. Shift supervisors are responsible for operation of the entire plant and implement any process changes made by process control engineers located at the operations management center. The Deer Island grit removal facility is made up of east and west centrifugal grit chamber batteries. Each

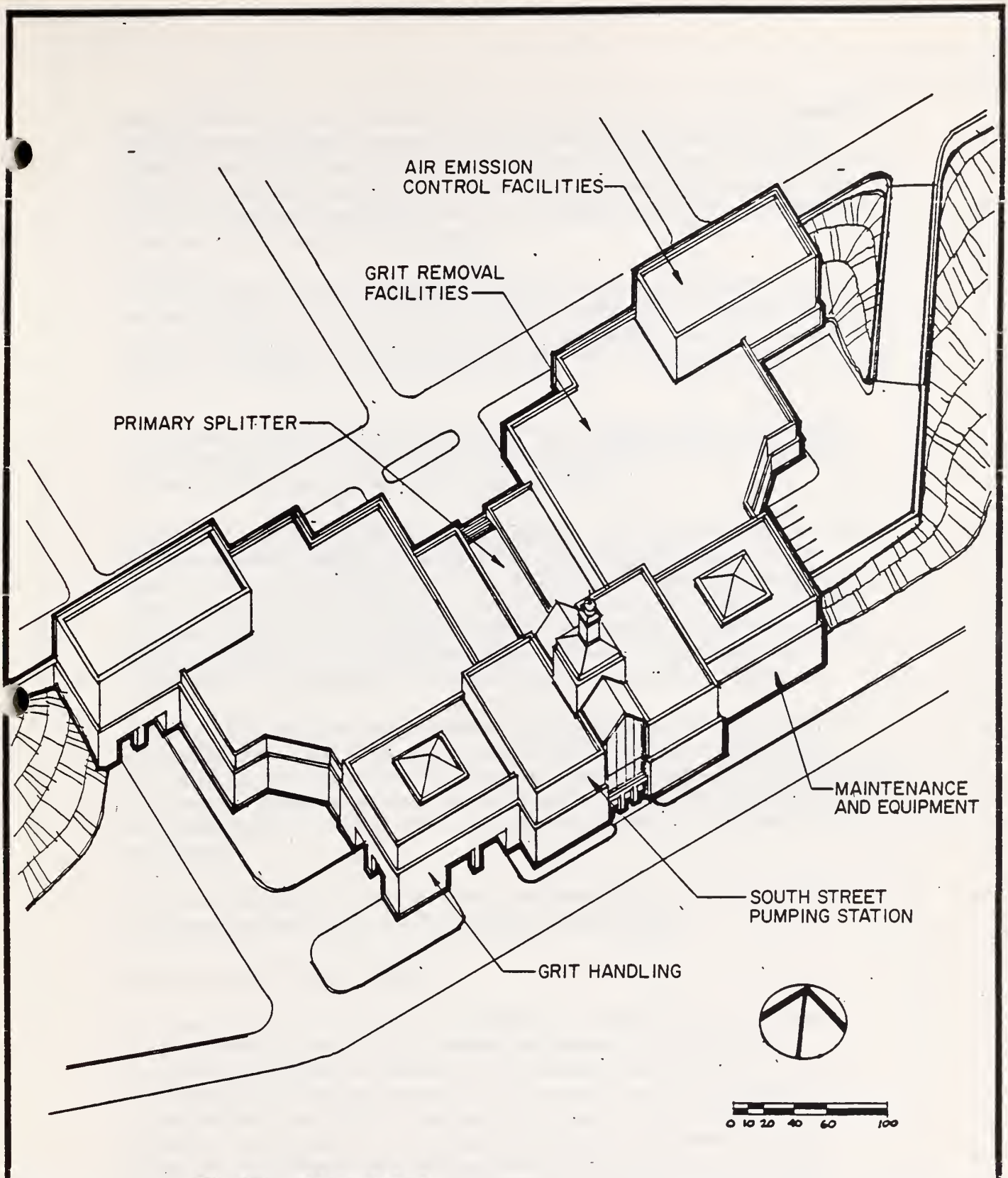


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**FIGURE 11.1.3-4**
**PRIMARY COMPLEX**
**ANOXOMETRIC VIEW**

battery is enclosed within a building that allows for air emissions control. The grit handling facilities consist of two levels: the upper level which contains cyclone separators and grit classifiers, and the lower which houses two drive-through grit loading bays. The grit removal and grit handling facilities, the primary splitter box, and the South System Pumping Station wet well are considered precautionary areas, and are, therefore, either physically separated or sealed from the other areas within the complex.

Located in the center of the treatment facility above the secondary sludge pumping station is the control center for the secondary treatment process. Included in this designated area is an operation control center which overlooks the secondary treatment process area, locker rooms, a lunchroom, office space, storerooms, maintenance area, HVAC facilities and electrical equipment rooms.

A third control center is located within the existing North Pumping Station buildings and is for operation of the power and North pumping facilities. It is expected that a control center will also be included as part of the residual processing area.

Support Facilities on Eastern Edge of Treatment Facilities. The oxygen generation plant is located on the eastern edge of the treatment facilities, adjacent to the primary clarifiers' Battery A and south of the aeration basins. The oxygen plant is an independent grouping of buildings and equipment that produces oxygen for use by the secondary treatment facilities. The oxygen plant consists of a 35-ft-high compressor and operations building, two 85-ft-tall distillation columns, and a 45-ft-high liquid oxygen storage tank. These facilities are located between the plants roadway system and the eastern shore buffering landform.

Along the eastern side of the main process area is a building housing the primary effluent screening facilities. These facilities treat effluent from Primary Battery A under extreme flow conditions. The majority of the structure is below grade and is connected by a passageway to the treatment facilities access zone. Above-grade portion of this facility consists of a single-storey brick faced building which houses associated air emission control facilities and electrical gear.

The potable water storage tank is also located on the eastern edge of the facilities, adjacent to the disinfection basins. This is a 2 million gallon elevated structure.

Plant Access and Personnel Circulation

As shown in Figure 11.1.3-5, access to Deer Island will be both overwater and overland. Overwater traffic will unload and be controlled at the proposed new pier facilities. A vehicular access road along the western side of the treatment facility will connect the pier to the administration building, the treatment facility lower zone, maintenance facilities, and residual facilities. The vehicular access road will be ramped up to the service roads at three locations: on the southeast corner of the treatment facilities, on the northern end of the facilities, and on the western face at the maintenance buildings adjacent to the secondary clarifiers. The service roads completely surround and access the upper facilities zone.

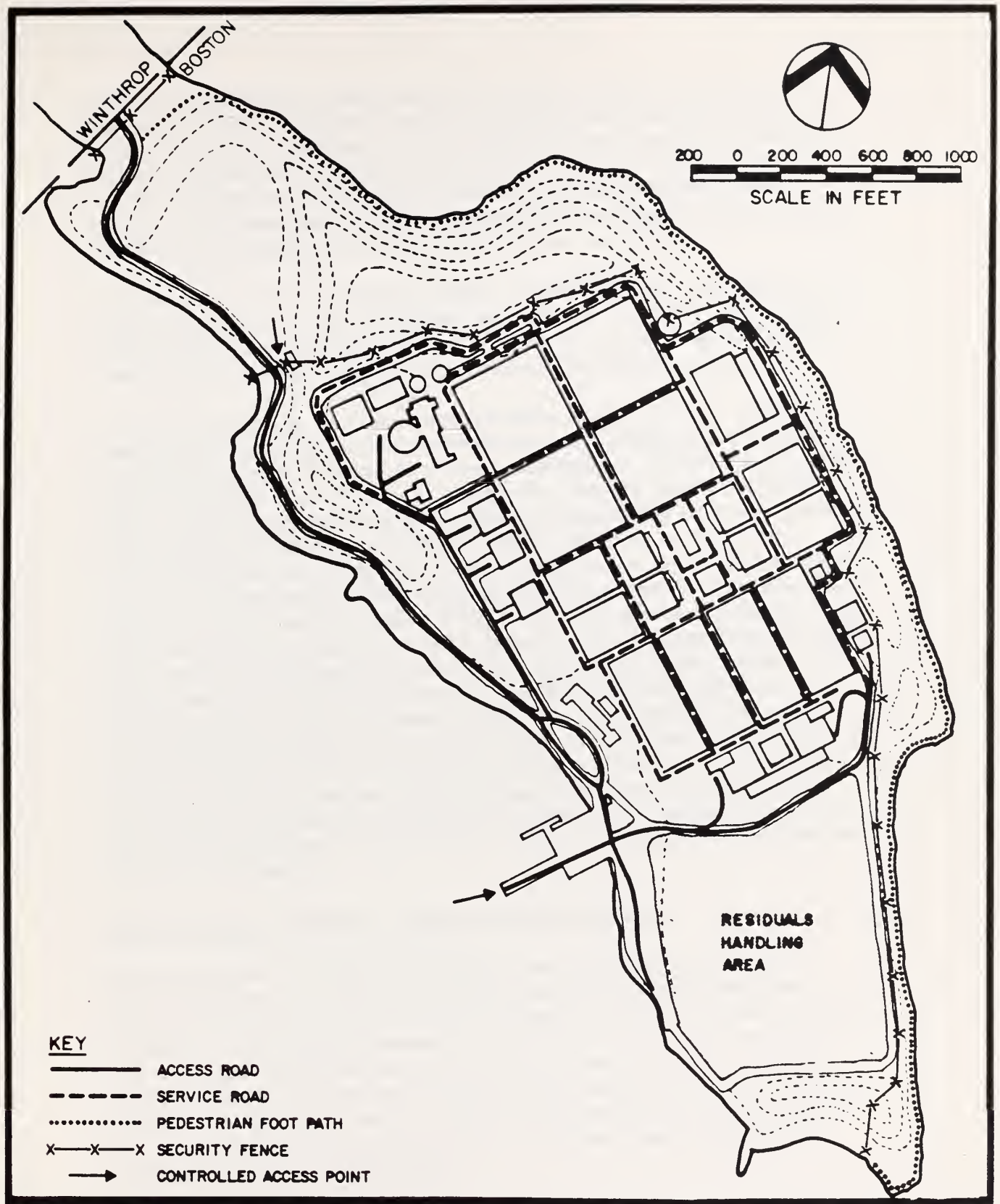


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**FIGURE 11.1.3-5**
**DEER ISLAND EXTERNAL ACCESS**

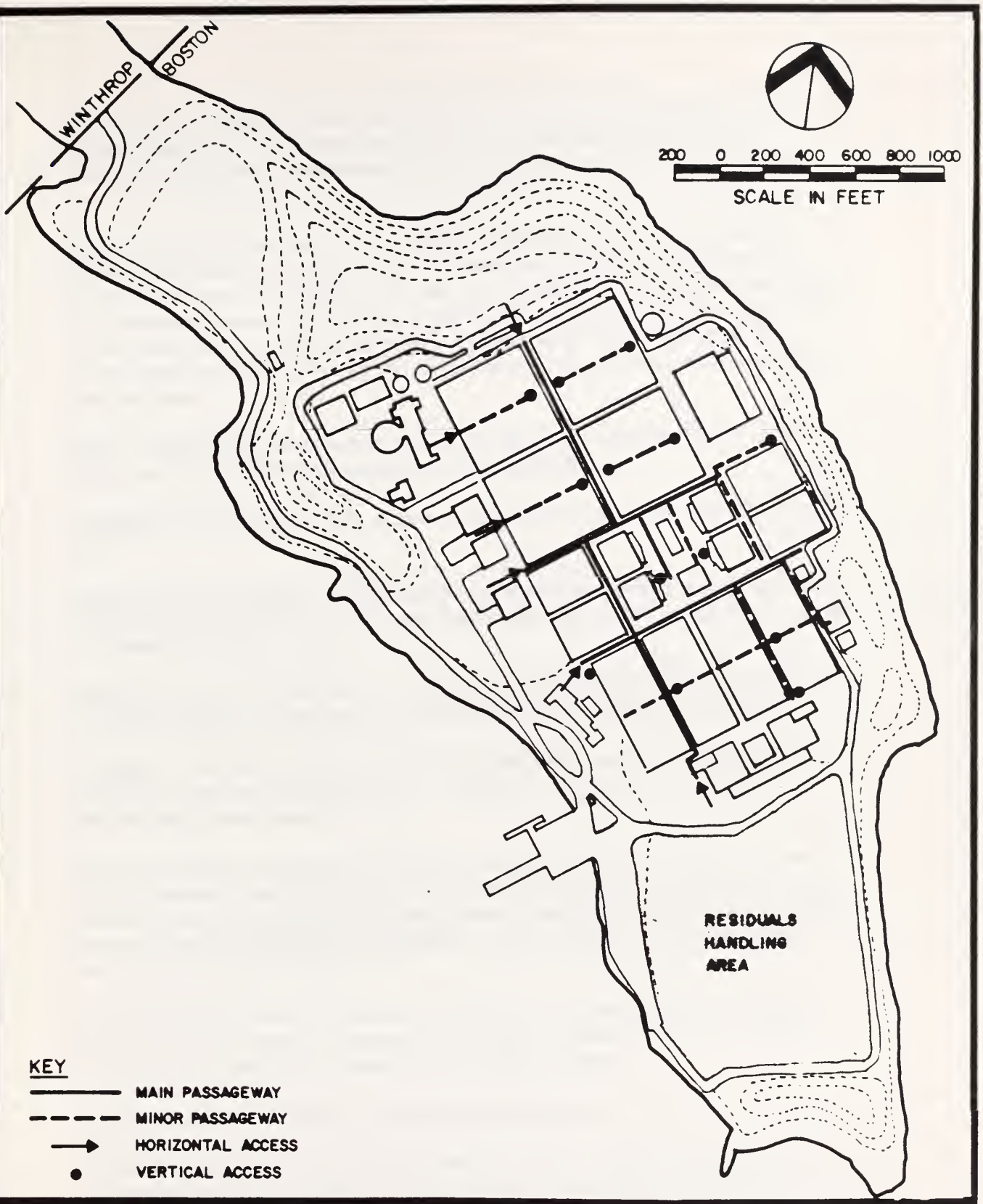
An overland vehicular access road will connect Point Shirley to Deer Island. This road will have controlled access at two points. One of the control points will be a fenced gate at the property line, adjacent to Point Shirley and the northernmost outer berm. The second control point will be the entrance to the treatment facilities at the limit of the buffer zone. This overland access roadway follows the western shoreline to the area of the administration building. This roadway alignment directs visitors from the overland access routes to the same common point, the administration building, as the overwater access routes.

Within the buffer zone, north and east of the plant, a pedestrian footpath is contemplated. It would commence at the northern gate near the man-made drumlin and follow the northeastern shoreline of Deer Island to its most southerly tip. A control fence located at the inland foot of the landforms will prevent pedestrians from entering into the treatment plant areas.

The internal system for the lower/access zone is as shown on Figure 11.1.3-6. Within the treatment facilities are numerous pipe galleries that have been configured to provide the plant with connected passageways between the various process elements. The main internal passageway is approximately 20 ft wide and runs from the pier area northward through the treatment facility. This passageway would have a floor elevation of approximately 125 ft at the southern end (corresponding closely to the invert of the lower basin of the two stacked primary clarifiers) and the passageway floor would then rise gradually to an elevation of approximately 130 ft at the northern end (which would correspond to the approximate invert elevation of the upper basin of the two stacked secondary clarifiers). Main East-West passageways run at right angles to the North-South passageway in three locations: the East-West passageway between the primary clarifiers and aeration basins connects to the administration building and the screening building; the East-West passageway between the aeration basins and the secondary clarifiers connects the vehicle maintenance building, secondary operations center, return activated sludge pump station, and plant water pump station; and the East-West passageway between the batteries of the secondary clarifiers connects the maintenance and parts storage facilities to the internal access system. Minor passageways and pipe galleries would be located between process batteries as necessary for equipment access. Egress and ventilation shafts from the passageways are typically located at the ends and midpoints of the primary and secondary clarifier batteries.

Materials Selection Considerations - Equipment, Piping and Tankage

Materials selection is an important consideration in the design and construction of the proposed Deer Island and Nut Island treatment facilities. Wastewater treatment plants, by their very nature, are in a moist environment and subject to corrosion. The Deer Island and Nut Island sites are particularly vulnerable to corrosion since they are also located in a salt water environment and the wastewater has relatively high levels of chlorides. Fog off the ocean will condense on exposed surfaces and will leave a coating of salt when the condensation evaporates. It is important to select and specify materials that will ensure optimal service life and provide an operable/maintainable facility. As a general guide, materials selection considerations should include the following:




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.1.3-6**
**DEER ISLAND INTERNAL ACCESS**

Concrete tanks and covers - In all areas where there is an air space in contact with a liquid surface beneath a cover, all exposed interior concrete surfaces should be provided with protective coatings (such as cast-in-place PVC liner). The protective coatings should extend down walls to a point below the low water line of the tank.

Wastewater piping - Pipes and conduits transmitting wastewater should be constructed of concrete or cement lined ductile iron or steel. Certain lines, such as those used for scum, should be glass lined. The major buried wastewater transmission lines should be constructed of PCC (prestressed concrete cylinder pipe) or cast-in-place concrete conduits with a rectangular cross-sectional shape. Any concrete lines which are not designed to flow full under all service conditions should be provided with the protective coating discussed above for concrete tanks and covers.

Valves - Valving should be of standard materials for the specific wastewater service, except that stainless steel options should be specified where applicable.

Air piping - Process air piping (low pressure service) should be thin-wall, Type 316 stainless steel.

Potable water service piping - Potable water piping should be of copper in areas where there is no potential for the formation and collection of hydrogen sulfide gases. In such areas, stainless steel would be an acceptable alternate.

Process equipment - The manufacturer's standard materials for a given service should be used for process equipment. Stainless steel components should be specified where applicable.

Ventilation - Ventilation ducts should be plastic or fiberglass. Fans should be fiberglass or protectively coated for the specific service. Ventilation air to electrical areas should be dehumidified to remove moisture and salt.

General - Electrical cables should be installed in open trays. In wet or damp areas where electrical conduit is used, the conduit should be PVC or coated and lined with PVC. Interior railings, grating, exposed metallic structural members, miscellaneous metals, and pipe hangers should be type 304 stainless steel or fiberglass. Exterior railings, gratings, stair casings, etc. should be anodized aluminum.

Materials selection should be considered in detail during preliminary design and specific recommendations made for each service area of the plant. Selection of materials will have to consider product availability in required sizes at the time of design.

Materials Selection Considerations - Architectural Components

Selection and specification of architectural materials is also an important consideration due to the moist, corrosive, salt water environment of the Deer Island and Nut Island sites. Support buildings can be constructed of steel or concrete, but they should be faced with a red

brick exterior. Exposed, exterior building components other than brick or concrete should be anodized aluminum or aluminum with a baked enamel finish. Type 304 stainless steel or fiberglass would also be acceptable materials. Doors, door casings, window casings and mullions, louvers, etc., should be of one of these materials. Galvanized steel and wood doors would be acceptable for normal service, interior areas. Fiberglass protection should be provided for building materials other than brick or concrete in areas subjected to chemical corrosivity, such as the chlorination facilities.

Selection of architectural materials should be considered in detail during preliminary design and specific recommendations made for each service area of the plant.

Architectural

The recommended facilities are most visible from the harbor approach on the western side of the island in the vicinity of the new piers. From this vantage point, the visibility of the piers is inevitable. Also prominently exposed is the historic old pumping station which is consistent with the goal to preserve the historic image of Deer Island. From a distance the visual image of the island will be a profile of man-made drumlins, evoking a natural habitat and generally screening the treatment plant. The multistorey support facilities will have as a background the exposed concrete wall of the treatment process basins. The exposed walls of the basin are proposed to have an architectural finish or fenestration. The selection of the finish would be the subject of detailed design studies. One possibility would be to install precast panels that could recreate the image of the stone-clad military fortifications that occur on nearby islands. Other visible features of the mechanical workings of the plant, such as air emission ducts, oxygen distillation columns, etc., will be clad in metal or fiberglass liners and appropriately colored to harmonize with the brick and concrete structures. The support buildings would be constructed of either concrete or steel, but it is recommended that they be finished with a red brick exterior.

Hydraulic Design and Hydraulic Profile

The recommended treatment facilities have been configured so that the wastewater is efficiently conveyed into and out of the various unit processes. The plant's hydraulic profile is determined by the headlosses associated with the hydraulic design parameters. Hydraulic design parameters for four elements of process flow govern the recommended plan. These elements are: flow splitting into the batteries of unit processes; inlet distribution to each of the basins within a battery; downstream outlet control from each of the basins; and the interprocess conveyance.

The resultant profile for the recommended facilities has a total headloss across the plant of approximately 16 ft at a peak flow of 1270 mgd. The hydraulic profile is shown in Figure 11.1.3-7. The recommended elevation under peak flow conditions at the influent to the North System grit removal facilities is 158 ft. This elevation is based on conservative headloss through control structures. During final design this elevation may be lowered, which will

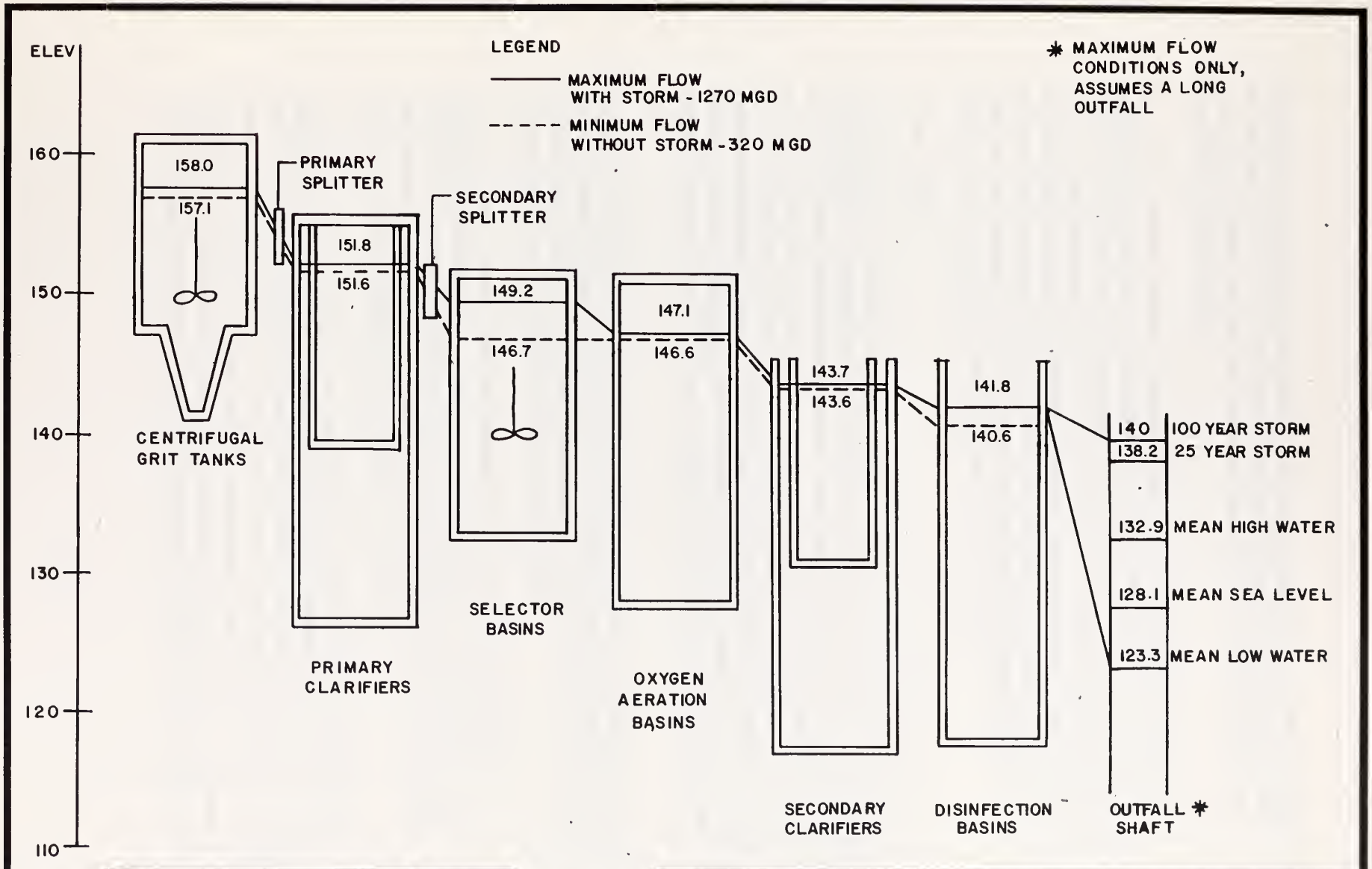



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**FIGURE 11.1.3-7**
**DEER ISLAND**
**HYDRAULIC PROFILE**

slightly reduce pumping and power costs. The recommended elevation requires pumping of all of the wastewater at the influent to the plant. Once the flow has been pumped into the facility it will flow by gravity - with that flow controlled and regulated by the various gates, and weirs located within the facility.

The vertical placement provides a sufficient elevation at the chlorine contact basin weirs (elevation 140.6 ft to 141.8 ft) for gravity flow within the outfall for the range of outfall options under consideration. At maximum flow the elevation of the outfall shaft ranges from 123.3 ft at mean low water to 132.9 ft at mean high water. At lower wastewater flows the elevation within the outfall shaft is lower. Therefore, during non-storm conditions a significant head is available at the plant outfall for potential energy recovery. A hydropower facility to take advantage of this drop in the outfall shaft should be studied after the outfall site has been selected and the plant hydraulic profile finalized.

Hydraulic Design

Flow Splitting. As previously presented in Figure 11.1.3-3, the treatment plant is divided into four batteries. The batteries are identified by the letters A, B, C, and D. Screened and degritted wastewater from both the North and South systems is collected at the primary splitter box. The splitter box is a common location upstream of the primary treatment basins from which the flow is distributed to each of the four batteries of primaries. Downstream of the primary treatment facilities and upstream of the secondary treatment facilities the wastewater is again collected to a common point, the secondary splitter box, and is distributed to each of the four secondary batteries. Flow distribution is achieved in this manner for all flows up to 1080 mgd.

All flows in excess of 1080 mgd will receive primary treatment and screening prior to mixture with the secondary effluent and disinfection. The operations procedure at the splitter boxes and the primary clarifiers during periods when the flow exceeds 1080 mgd are described in the following section on recommended primary treatment facilities.

The flow splitters will be hydraulically controlled by a flow regulating gate located downstream of the splitter box on the conduit from the splitter box to the battery. A venturi is located between the splitter box and the flow regulating gate on each conduit for flow measurement. The signal from the venturi will act as the feed to the gate. Isolation gates will be located on the splitter box at the influent to each conduit.

Inlet Distribution to the Basins. An equal distribution of flow from the conduit feeding a battery into each of the process basins within the battery is necessary to achieve a uniform level of treatment. For both the primary clarifiers and the secondary clarifiers, the conduits discharge to the center point of an aerated inlet channel. The influent channel to the primary clarifiers is 530 ft long. The inlet channel to the secondary clarifiers is 420 ft long. The hydraulic design used to achieve equal flow distribution to the process basins, regardless of which individual basins within a battery are operational, is to induce a high headloss at the

individual basin inlet relative to headlossses within the aerated influent channel. For this facility plan a headloss value of 1.5 ft at the inlet to the individual basins under peak flow conditions has been used. This value is consistent with induced headloss required for equal flow distribution at actual plants. An induced 1.5 ft headloss is also used to distribute flow from the aerated influent channel to the oxygen aeration basins.

There is no induced headloss for the inlet to the anaerobic selectors. There is one anaerobic selector basin for each battery, and the anaerobic selector basin has been configured to allow for variations in flow path and pattern within the basin. However, there is no need to subdivide the flow since the selectors are designed as single flow-through units for each battery. At various locations throughout the plant, isolation gates are furnished. These gates are not intended to function as flow control devices.

Outlet Control from the Basins. The outlet from the basins is hydraulically controlled by weirs. Outlet weirs have been located at the North System grit facilities, the primary clarifier basins, the oxygen aeration basins, the secondary clarifier basins, and the chlorine contact basins. There are no weirs on the outlets from the splitter boxes or the outlet from the anaerobic selector basins. The hydraulic design includes a minimum allowance, during peak flows, of 3 inches between the weir elevation and the downstream water elevation. This allowance prevents the submergence of the weirs.

The length of the outlet weirs at each basin is determined by the geometry of the basin and its treatment function. A description of each of the outlet weirs is contained within the subsequent description for each of the unit processes.

Interprocess Conveyance. The size and shape of the recommended interprocess conveyance conduits is based upon the volume of flow to be conveyed and the acceptable maximum and minimum velocities. The large volumes of flow that must be conveyed and the need for ease of construction resulted in the recommended facilities using square conduits for the majority of interprocess conveyance.

From the primary splitter box to the primary influent channel and for the effluent conduits from the primary batteries, 9 ft by 9 ft conduits are recommended. Within the secondary treatment facilities, from the selector basins to the aeration basins and from aeration basins to secondary clarifiers, the conduits must be sized to convey both the wastewater flow and the return activated sludge flow. The recommended conduit sizing within the secondary facilities is 14 ft by 14 ft. The secondary clarifier effluent conduits are sized at 11 ft by 11 ft and discharge into one of two 20 ft by 20 ft conduits, each of which feeds the four chlorine contact basins. In calculating the headlosses associated with the interprocess conduits the length of the longest conduit was used. The Darcy-Weisbach resistant coefficient of 0.013 was used.

The maximum velocity in the 9 ft by 9 ft conduits would be 6.4 ft per second. The velocity under average day low groundwater flow conditions would be 2.2 ft per second. The maximum velocity in the 11 ft by 11 ft conduits would be approximately 4.6 ft per second.

The velocity under minimum flow conditions would be approximately 1 ft per second. The maximum and minimum velocity in the 14 ft by 14 ft conduit is dependent upon both the plant flow and the return activated sludge flow. The expected range of velocities in the 14 ft by 14 ft conduits would be from 0.8 ft per second to 3.3 ft per second.

Circular pipelines are utilized for the influent pumping system forcemains, for the return activated sludge system and for the screened primary effluent. The North System Pumping Station and Winthrop Terminal will be pumping to the North System grit facilities via twin 11.5 ft forcemains. The South System Pumping Station will pump to the primary splitter box through a 10-ft-diameter forcemain. The return activated sludge will be withdrawn by gravity from the secondary clarifiers and conveyed via 7-ft-diameter conduits - one for each battery of secondary clarifiers - to the return activated sludge pumping station located in the center of the plant. The RAS for each secondary battery is then pumped via 7-ft-diameter forcemains to the influent of the anaerobic selector basins.

The screened primary effluent would be conveyed to the disinfection basins via a 7-ft-diameter circular pipeline. This pipeline discharges to the 20 ft by 20 ft conduits from the secondary clarifiers.

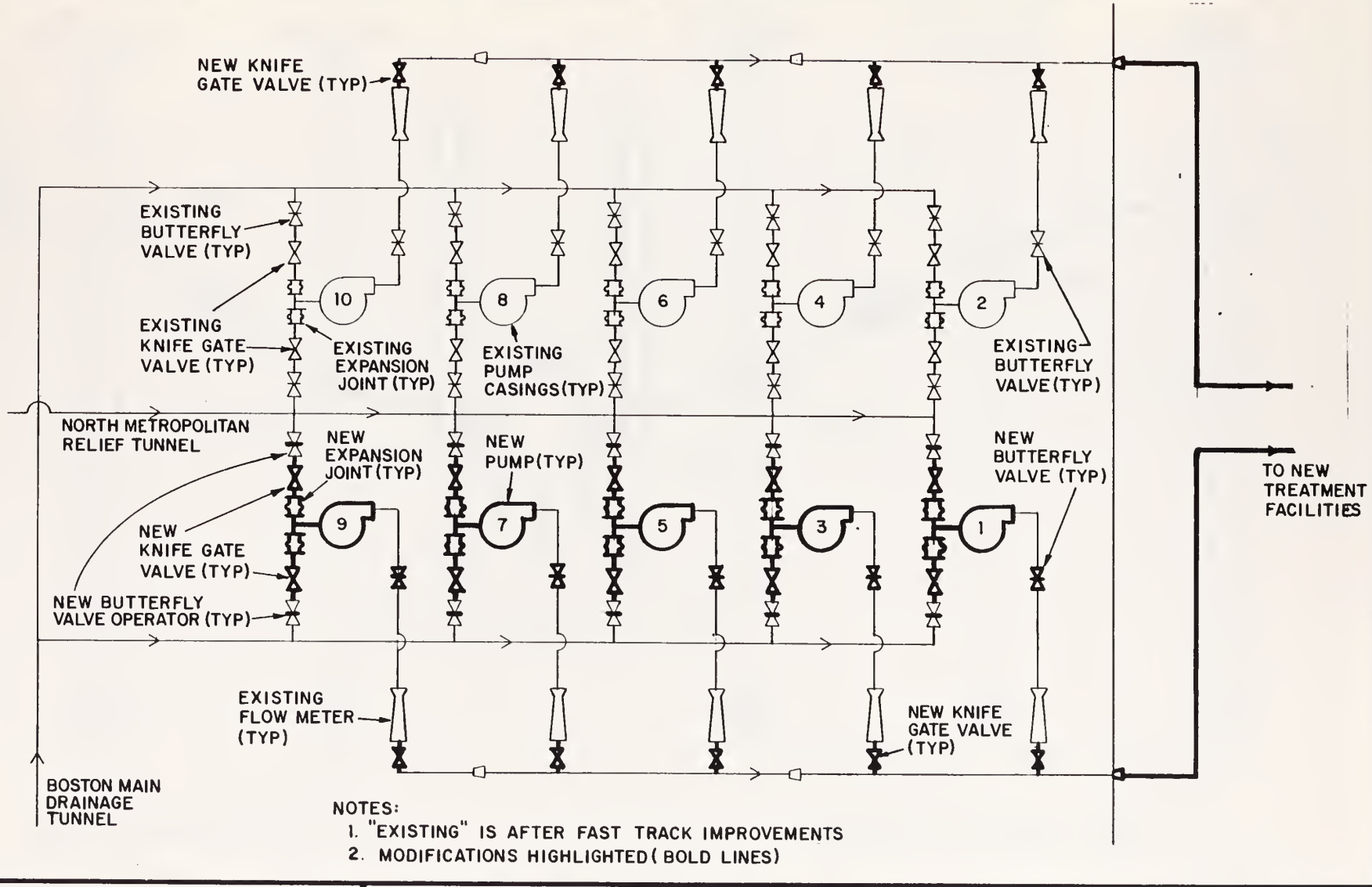
Modifications To Main Pumping Station

The existing Main Pumping Station at Deer Island will require modifications in order to pump flow from the North Metropolitan Relief Tunnel and the Boston Main Drainage Tunnel to the new treatment facilities. The major changes include replacement or modification of all ten pump units, including electric motor and variable speed drives and the addition of new knife gate valves on the suction of five pumps and on the discharge of all ten pumps.

The new system flow diagram is shown in Figure 11.1.3-8; the suction and discharge hydraulic gradients for the new system are shown in Figures 11.1.3-9 and 11.1.3-10, respectively. As shown on the gradients, the required pump tdh is 135 ft. Four pumps are required for the peak design flow of 350 mgd from the North Metropolitan Relief Tunnel. The system head curve for all flows in this tunnel is shown on Figure 11.1.3-11. Five pumps are required for the peak design flow of 438 mgd in the Boston Main Drainage Tunnel. The system head curve for all flows from this tunnel is shown on Figure 11.1.3-12.

To meet these operating conditions, ten new pumps, each rated at 90 mgd at 135 ft tdh will be installed. Five pumps, numbers 2, 4, 6, 8 and 10, are being installed as part of the fast track improvements. As indicated in Figure 11.1.3-8, new pumps including casings and impellers will be installed at units, 1, 3, 5, 7 and 9. According to the manufacturer of pumps 2, 4, 6, 8 and 10, new impellers may be installed inside the existing casings to provide the increased discharge head capacity.

A new electric motor and variable speed eddy-current coupling drive will be installed with each of the ten pumps. Each motor will be rated at 3,000 horsepower. Figure 11.1.3-13 presents a cross section view of the pumping station showing this equipment. Based on preliminary




NOTES:
1. "EXISTING" IS AFTER FAST TRACK IMPROVEMENTS
2. MODIFICATIONS HIGHLIGHTED (BOLD LINES)

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**FIGURE 11.1.3-8**
**MODIFIED MAIN PUMPING STATION FLOW DIAGRAM**

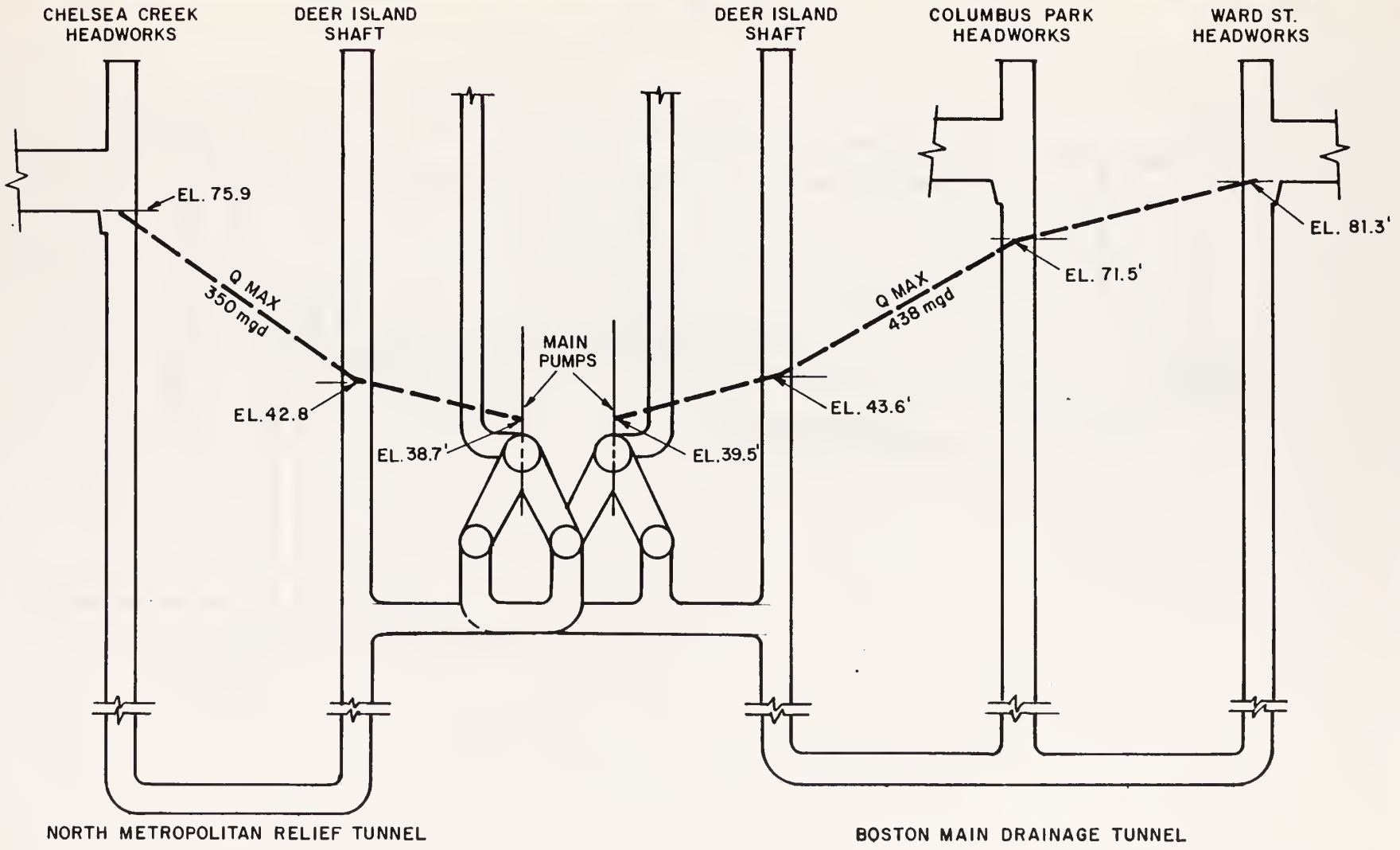


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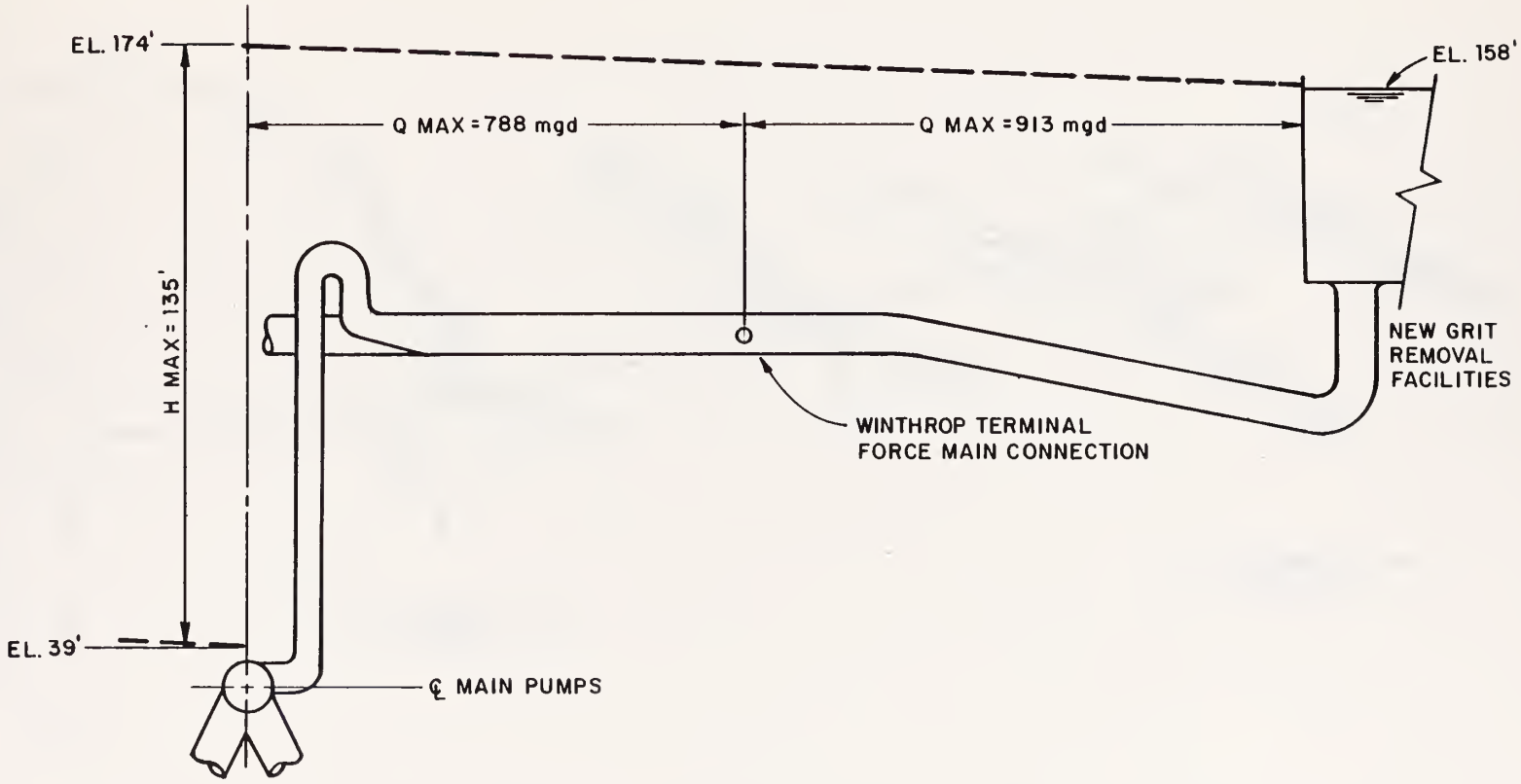
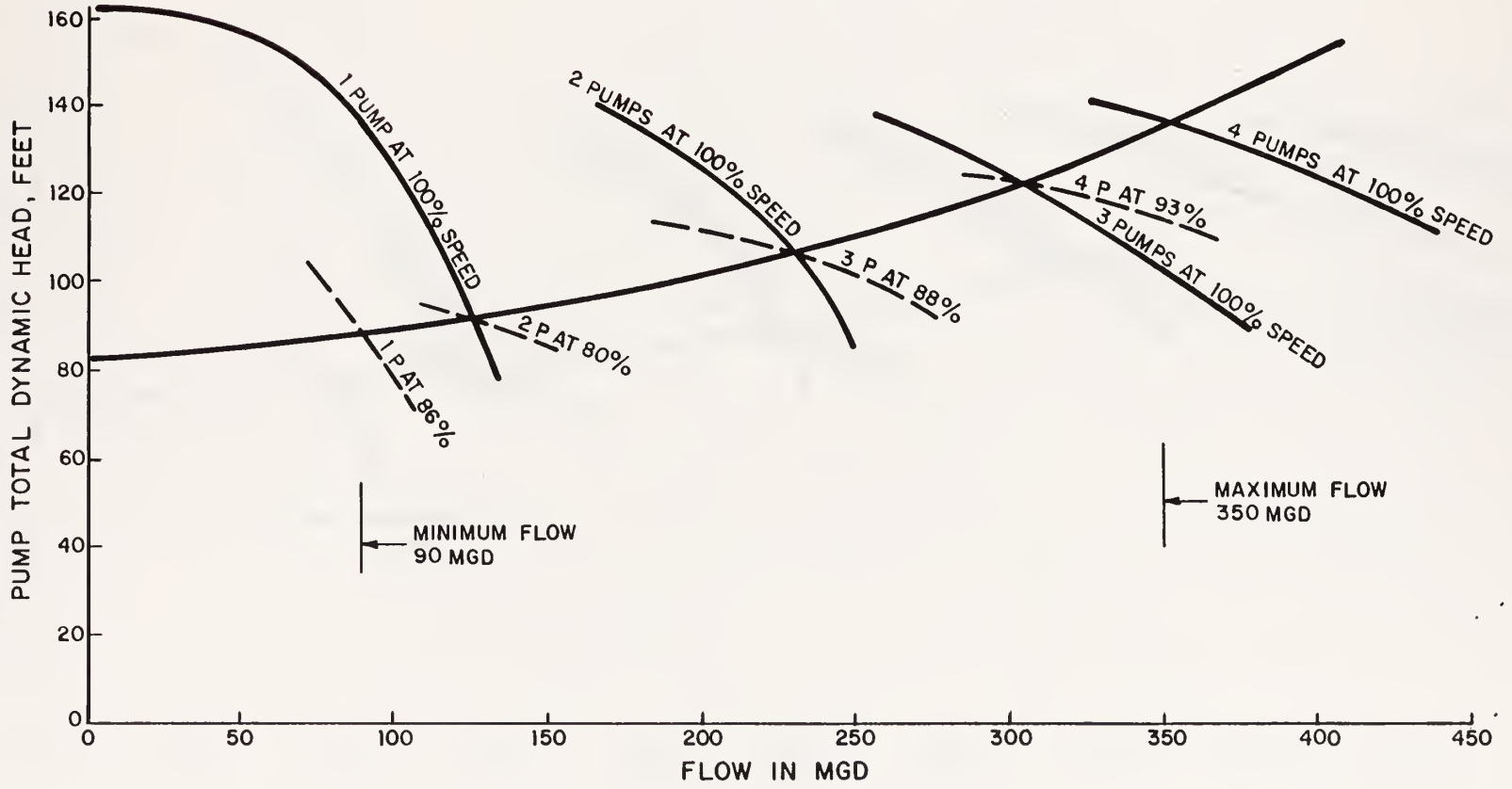
**FIGURE 11.1.3-9**
**HYDRAULIC GRADIENT OF TUNNEL SYSTEM TO MAIN PUMPING STATION**




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.1.3-10<br>HYDRAULIC GRADIENT<br>MAIN PUMPING STATION TO NEW TREATMENT FACILITIES |
|---|---|




| | |
|---|---|
| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.1.3-11<br>PUMP OPERATING MODES - MAIN PUMPING STATION<br>NORTH METROPOLITAN RELIEF TUNNEL |

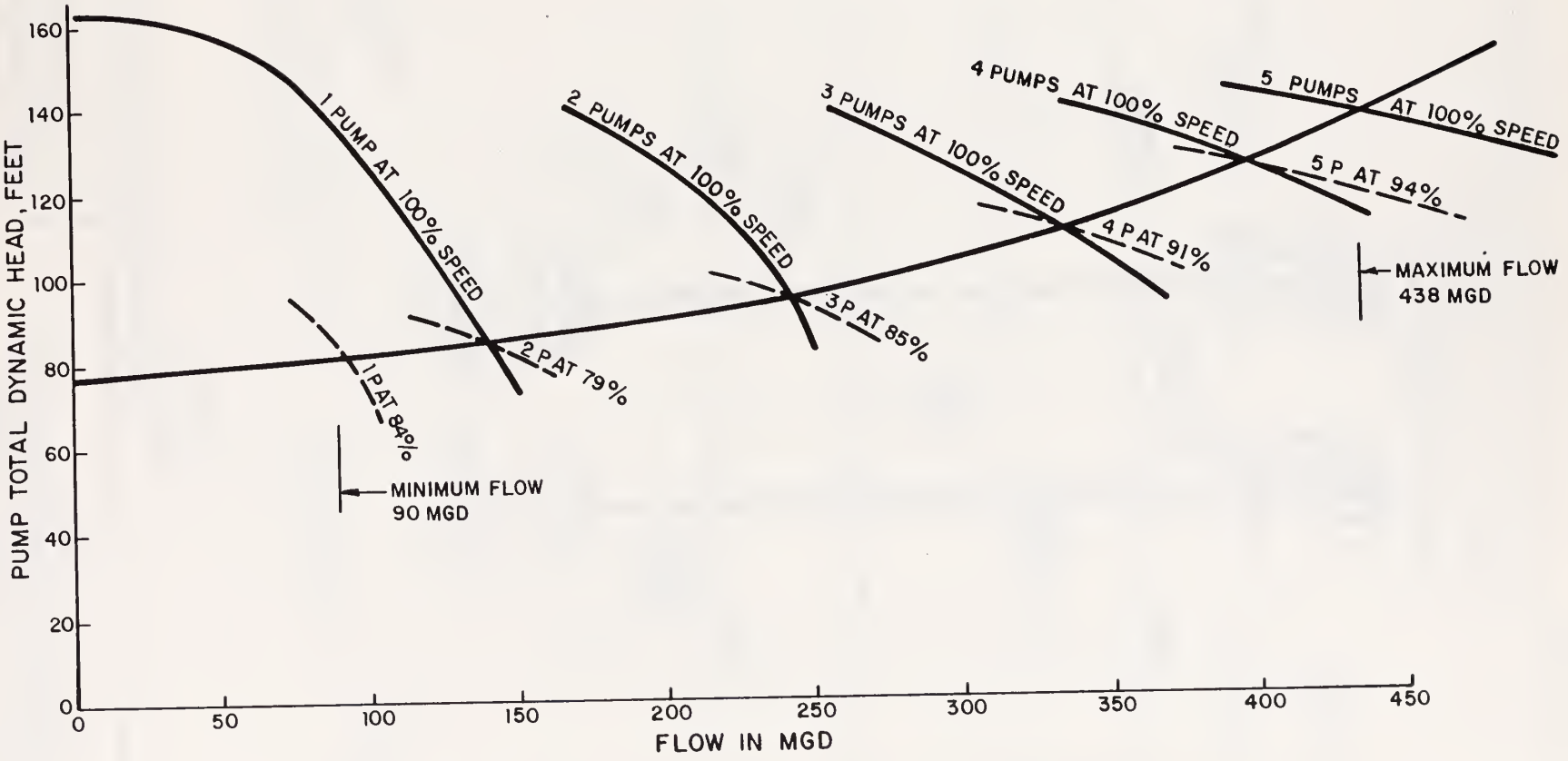



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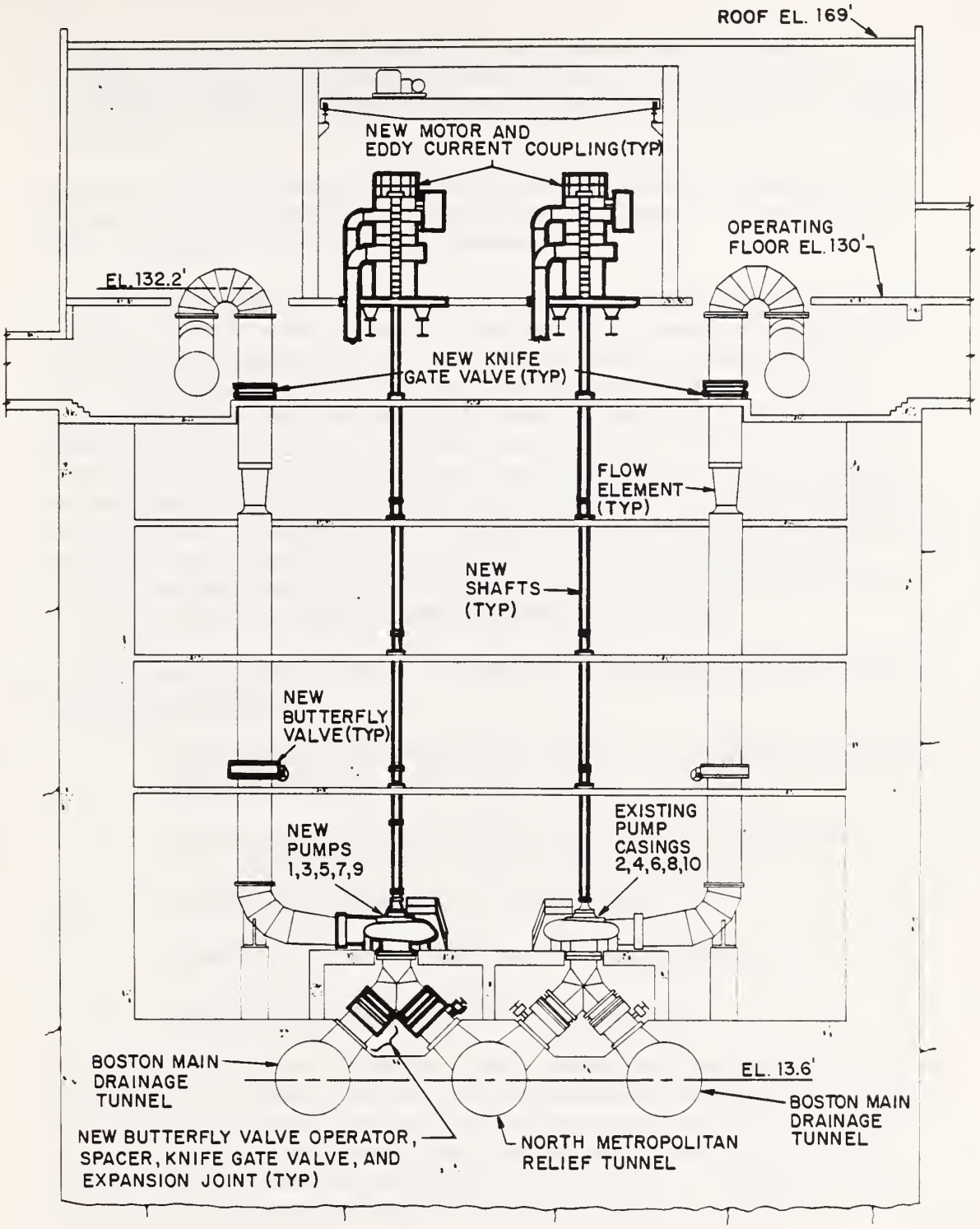
**FIGURE 11.1.3-12**
**PUMP OPERATING MODES - MAIN PUMPING STATION**
**BOSTON MAIN DRAINAGE TUNNEL**




SECTION

NOTES:
1. "EXISTING" IS AFTER FAST TRACK IMPROVEMENTS
2. MODIFICATIONS HIGHLIGHTED (BOLD LINES)

| | |
|---|---|
| **MASSACHUSETTS WATER RESOURCES AUTHORITY** | **FIGURE 11.1.3-13 MODIFIED MAIN PUMPING STATION EDDY CURRENT COUPLINGS** |

analysis, the electrical switchgear configuration existing after fast-track improvements is suitable for the new loads. As discussed in Section 10, pumps rated larger than 90 mgd should be considered during detailed design. The impact of larger pumps on the switchgear must also be considered.

The need to replace the driveshaft and bearings between the drives and the pumps must be evaluated during final design when actual speeds and loads are known. For cost estimating, it has been assumed that replacement will be required.

As shown in Figures 11.1.3-8 and 11.1.3-13, major piping modifications are also required. For pumps 1, 3, 5, 7 and 9, new butterfly valve operators, knife gate valves, rubber expansion joints, and piping modification are required on the suction, and new butterfly valves are required on the discharge. Also, a new knife gate valve must be installed in all ten pump discharge lines downstream of the existing flow meters since, as shown by the hydraulic gradient in Figure 11.1.3-10, the entire piping system downstream of the pumps will be under pressure after the modifications are completed. This valve will provide a means of removing the flow element or the butterfly valve from the pump discharge line; will serve as a backup to the butterfly valve for isolating duty when a pump is removed for maintenance; and will provide valving redundancy consistent with the suction piping. Based on visual inspection and discussion with operations personnel the steel discharge piping appears to be adequate. This must be evaluated by performing non-destructive testing during final design.

Additional major changes and renovations required to complete the modifications of the Main Pumping Station include:

- Removal of diesel engines driving pumps 1, 3, 5, 7, and 9, including all associated piping and equipment
- Removal of the vacuum priming system for the discharge piping loop seals
- Extension of HVAC system for new motors and drives
- Replacement of all power cable between switchgear and pump motors
- Addition of new pump speed controls for all ten pumps

Nine of the ten installed pumps would be required to operate should the peak design flow occur concurrently in each tunnel. One pump would be a backup and could take suction from either tunnel. To provide additional redundancy, it is recommended that two additional pump units (motor, coupling, drive shaft, impeller, casing, etc.) and valving (butterfly valve, knife gate valve, and rubber expansion joint) be purchased and stored onsite. In the event that a spare component is used, it would be reordered to maintain adequate spares in storage.

North System Force Mains

Two force mains will be constructed to convey wastewater from the North Main Pumping Station and Winthrop Terminal to the North System grit facilities. The force mains have an 11.5 ft inside diamater and slope constantly downhill from the North Main Pump Station to the North System grit facilities.

Each of the force mains is dedicated to one of the two North Main Pump Station headers (5 pumps total per header), and to one of the two Winthrop Terminal headers (3 pumps per header). Each force main discharges to one of two grit batteries (8 centrifugal grit chambers). The North Main Pumping Station headers are 9.5 ft steel sections that will be connected via a transition to the 11.5 ft force mains. The headers discharge on the southern side of the North Main Pump Station. From the North Main Pump Station the force mains proceed eastward, passing between the existing Winthrop Terminal Facility and the existing Winthrop Terminal grit facilities.

The force mains turn and head westward approximately 450 ft after passing the Winthrop Terminal structure. This alignment avoids conflict with the existing outfall conduit and with the North Metropolitan Sewer. The force mains then turn and run southward approximately 1400 ft following the western shoreline of the island to a point south of the old steam pumping station. At this point the force mains will be located between the shoreline and the existing outfall. The force mains slope gradually downward from an invert elevation of 109 at Winthrop Terminal to approximately invert elevation of 99 at the point south of the old steam pump station. The force mains then turn eastward and cross beneath the existing outfall. This will result in an approximate invert elevation of 84. The force mains then proceed in an easterly direction approximately 900 ft, sloping gradually downhill, to the grit facilities where the force mains will turn and rise vertically up to a free discharge at elevation 158. The force mains run downhill to the grit facility influent, where if necessary a clamshell could be lowered into them for cleanout and maintenance access.

The selection of flow to a particular force main and, by extension, to a particular grit facility (either the eastern or western grit facility) is determined at the North System pumping facilities in the selection of the number of pumps withdrawing from each influent well (either Boston Main Drainage Tunnel or North Metropolitan Relief Tunnel).

The recommended alignment was selected to minimize interference with the operation of the existing treatment facility. The sequence of construction to connect the new force mains to the existing North System pump facilities is described in detail in Section 11.2.1. Briefly, the force mains will be connected one at a time, and will have a connection from the new force main to the existing facility for use as necessary during the primary plant's start-up period.

South System Pumping Station

A new pumping station will be constructed at Deer Island to pump the South System wastewater to the new treatment facilities. As shown in the system flow diagram, Figure 11.1.3-14, the South

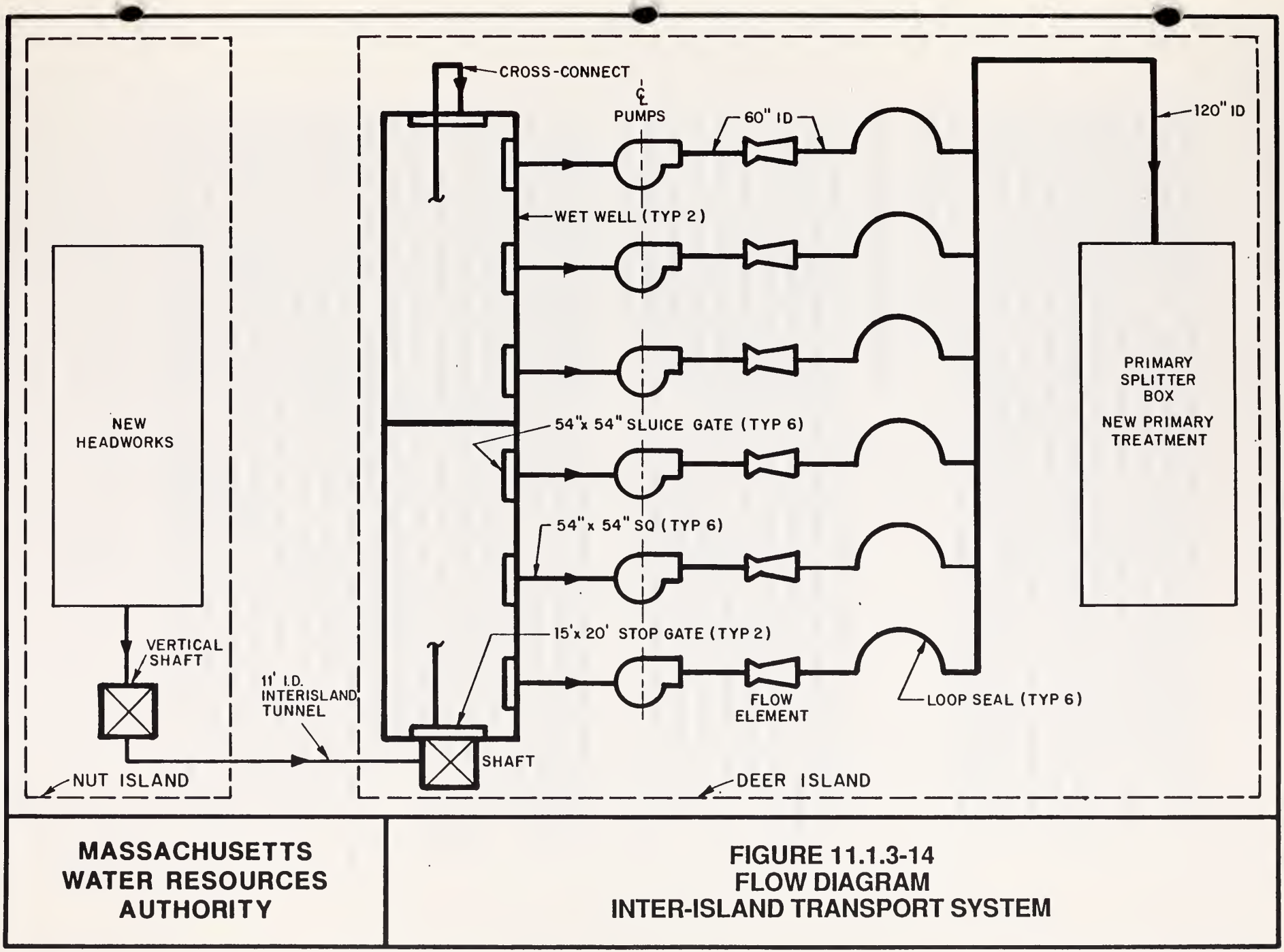



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**FIGURE 11.1.3-14**
**FLOW DIAGRAM**
**INTER-ISLAND TRANSPORT SYSTEM**

System Pumping Station will receive flow from the inter-island conveyance system and deliver it to the primary splitter box. The discharge header is 10 ft in diameter and discharges to the invert of the splitter box. All pumps are driven by electric motors supplied by the two separate and redundant sources of electric power. To efficiently pump the wide range of design flows from 80 mgd to 360 mgd, six pumps (four operating and two spares) each with variable-speed eddy-current coupling, are recommended. Four pumps in operation at peak flows were selected because these pumps can be driven by 2000 hp motors. Since the Fast-Track Improvement Program includes the installation of 2000 hp motors at the Main Pumping Station, consideration will be given to using these motors at the South System Pumping Station. The required pump operating modes are shown on Figure 11.1.3-15. The pump station structure is a portion of the primary control structures. Plans and sections of the recommended station are shown in Figure 11.1.3-16.

Deer Island Grit Removal Facilities

The Chelsea Creek, Columbus Park, and Ward Street remote headworks provide adequate grit removal to prevent deposition of grit in the North Systems wastewater conveyance tunnels, and to protect the raw wastewater pumps, at the North Main Pumping Station. However, additional grit removal facilities on Deer Island are needed to protect new moving mechanical equipment; to minimize the deposition of grit facilities in the new treatment plant conduits, channels, and basins, and to protect residuals handling. Also, the Deer Island grit facilities would provide the necessary grit removal for the Winthrop Terminal flows. Grit removal is required prior to the stacked primary clarifiers. The grit facilities receive flow from the two 11.5 ft diameter North system force mains that transport flow from the North Main and the Winthrop Terminal pumping stations.

The Deer Island grit removal facility consists of centrifugal grit chambers, grit concentrating and grit washing equipment, and grit truck loading bays. The grit chambers are split into east and west batteries made up of 8 grit chambers each. The east battery receives flow from one of the two force mains, while the west battery receives flow from the other. The peak flow that would be delivered to the combined east and west batteries is 913 mgd, however, each of the batteries has the capacity to accommodate the 514 mgd peak flow per force main with 7 of the 8 grit chambers operating. For normal daily variations in wastewater flows a constant number of grit chambers will be used, however, for extreme flow variations, grit chambers may be added or taken out of service as necessary. Settled grit is removed from the grit chambers by periodically pumping into a header piping system for transport to grit concentration and washing. Two 150 gpm torque flow pumps with constand speed 5 hp motors are provided for each grit chamber, one of which is required for operation with the second pump on standby. The pumps discharge to a parallel piping header system configured such that any segment of pipe can be maintained and replaced without disrupting the grit removal process. Concentration and washing for both east and west grit facilities takes place in a single grit handling building having an area of approximately 3000 $ft^2$. Separation of grit from each grit battery will be accomplished by 5 cyclone separators, three of which are operated at peak conditions. A total of 10 grit cyclones will be provided. After separating the grit, organic material is washed

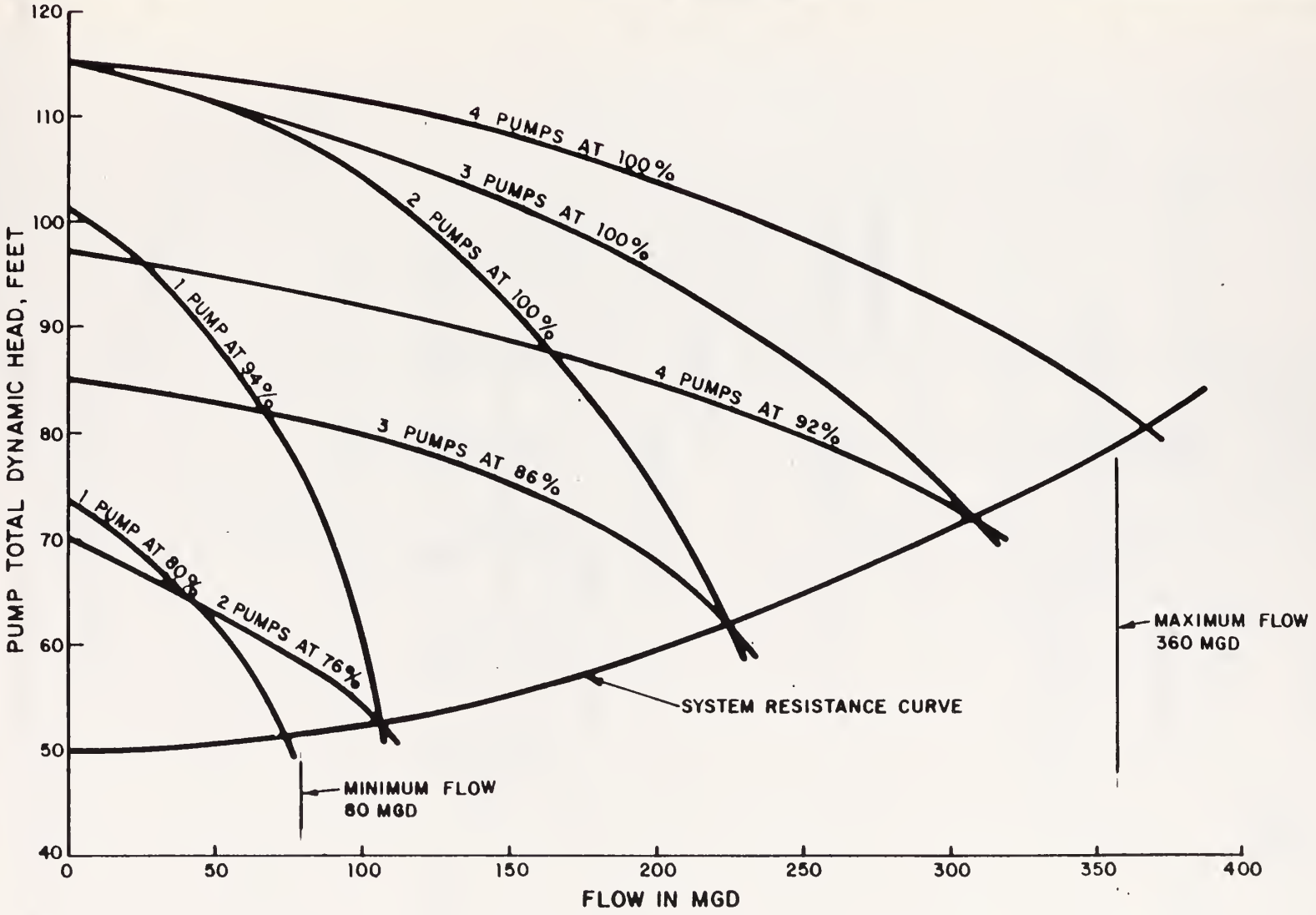


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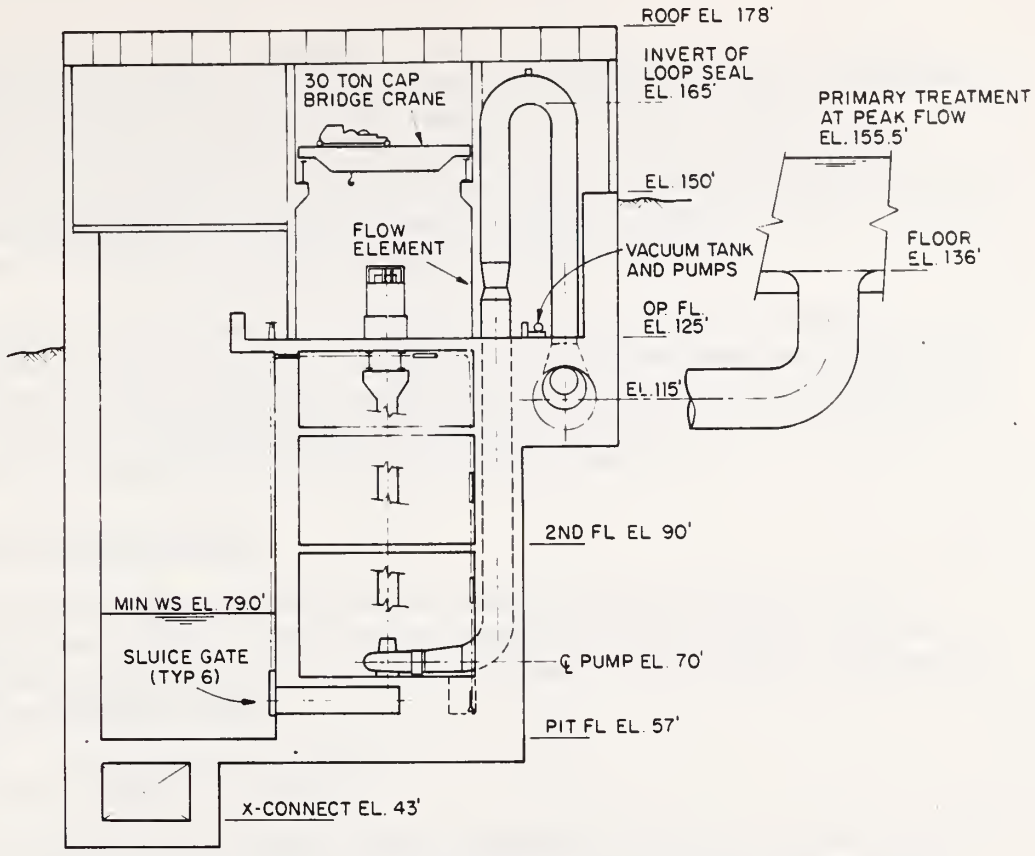
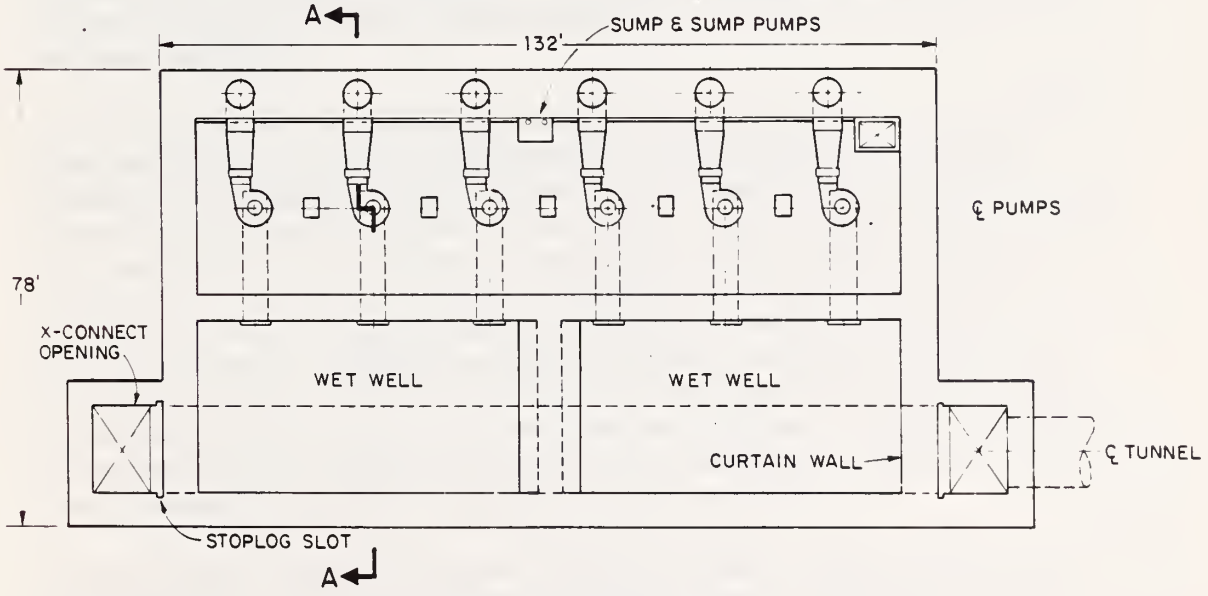
**FIGURE 11.1.3-15**
**PUMP OPERATING MODES**
**SOUTH SYSTEM PUMPING STATION**




SECTION A-A




PLAN AT PUMP FLOOR

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**FIGURE 11.1.3-16**
**SOUTH SYSTEM PUMPING STATION**

from the grit using inclined classifiers. A total of 10 classifiers are used, each associated with one of the cyclones. Once the grit has been concentrated and washed, it is transported by one of two conveyors to one of two grit loading bays located directly beneath the grit building. Grit is then trucked via roll/on roll/off barges to residuals handling facilities. The anticipated quantity of grit generated at Deer Island on an average daily basis is 30 to 32 $yd^3$ depending on the grit removal efficiency of the remote headworks. Based on a peaking facgtor of 3.0 volumes of up to 95 $yd^3$ per day may have to be handled.

Air emissions control facilities are provided for the grit chambers and grit handling facilities. The 19,000 cfm of air flow form the east grit chamber battery and the 21,000 cfm of air flow from the grit handling building are treated in the East Air Emission Facility. The 19,000 cfm of air from the west grit chamber battery is treated at the West Air Emission Facility. Air emissions are discussed further in this Section 11.1.3.

Primary Treatment Facilities

The primary treatment facilities include four batteries of stacked rectangular primary clarifiers and travelling screens to treat the portion of plant flow that receives only primary treatment. This section describes the primary facilities including unit sizing, equipment and the flow distribution scheme.

Primary Treatment Flow Distribution

North System wastewater flows are conveyed from the Deer Island grit removal facility to the primary splitter box through four 9 ft by 9 ft conduits. The flow from the South System Pumping station is conveyed to the splitter box through a 10-ft-diameter pipe. Also, the sidestream flow from the residuals treatment process enters the wastewater treatment process at the primary splitter box.

In the splitter box, the North and South system flows and the sidestream flows are mixed and distributed to each of the primary clarifier batteries. Flow is distributed to each battery through 9 ft by 9 ft conduits. The flow to each battery is measured in each conduit by a venturi with a recording flow range of 45 to 425 mgd. For the time period when only primary treatment facilities are operating, before the secondary treatment facilities are on line, all of the flow up to the primary plant capacity of 1270 mgd will be distributed equally to the four batteries. However, treatment plant operators have the capability to vary the flow to each of the batteries by regulating downstream control gates. The primary clarifier effluent is transmitted through 9 ft by 9 ft conduits to the secondary splitter box for distribution to the secondary treatment process. During the period when only primary facilities are operating, primary effluent will be screened and used for the plant water system. Operation of the plant water system during this period is discussed further in Section 11.2.1.

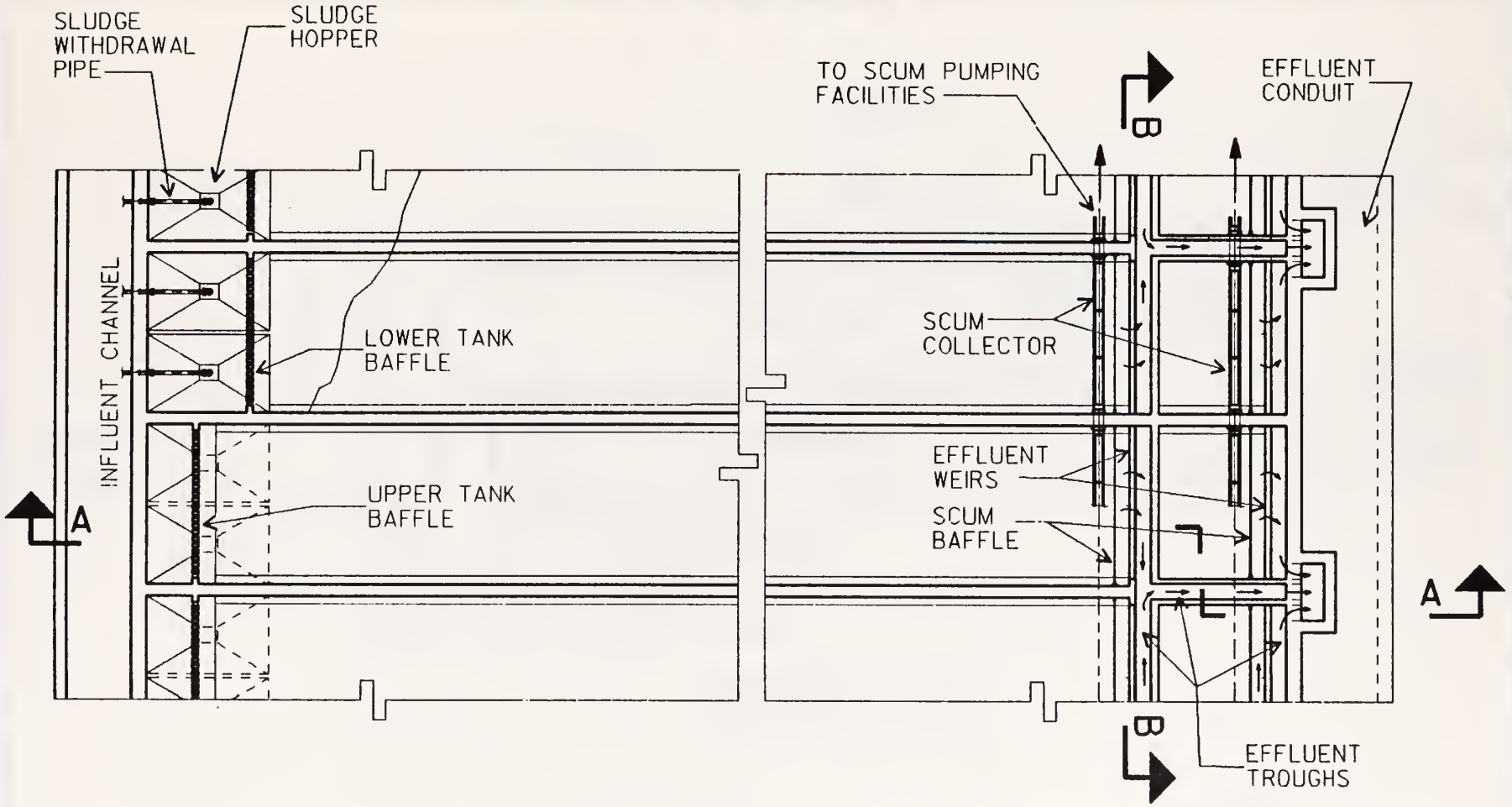
Once the secondary treatment facilities are operating, the primary treatment facilities will operate differently. For wastewater flows of 1080 mgd and less, the flow would normally be distributed evenly to the four primary clarifier batteries. When the treatment plant flows

exceed the secondary treatment capacity of 1080 mgd, the distribution of flow through the primary facilities is controlled in a specific manner. At flows above 1080 mgd, the flow to primary clarifiers in Battery A is set at 190 mgd by the influent venturi and associated flow control gate. Under these conditions, all or a portion of the effluent from Battery A is delivered to the travelling screens prior to disinfection. The effluent from Battery A flowing to the secondary splitter box is measured through a venturi and regulated by a downstream control gate. The venturi has a recording flow capability of 20 to 200 mgd. Flow recording/control from this venturi is only required when influent flow to Battery A is limited to 190 mgd. During the periods when flows through Battery A are allowed to exceed 190 mgd, the Battery A effluent will pass through the venturi with no recording/control required. The quantity of flow that does not receive secondary treatment is equal to the differences between the actual flow and the secondary treatment capacity of 1080 mgd. This difference will vary between 190 mgd and 0 mgd as flow to the plant varies from 1080 mgd to 1270 mgd. The remaining portion of the 190 mgd flow through Battery A is delivered to the travelling screens, and does not receive secondary treatment.

Primary Clarifiers

Primary treatment will be provided using stacked rectangular clarifiers. Stacked clarifiers consist of two tanks, one directly above the other, operating on a common water surface. Each tank in a stacked clarifier set is fed independently, resulting in parallel flow through the upper and lower tanks. Settled solids are collected from each tank by chain and flight collectors and are discharged to a common hopper. The effluent from both the upper and lower tanks discharges over transverse weirs into an effluent trough. Plan and sectional views of the stacked primary clarifiers are shown in Figures 11.1.3-17 through 11.1.3-19. The primary clarifiers are arranged in four batteries each of which consists of 24 stacked clarifiers (48 tanks). Under peak flow conditions, 21 stacked clarifiers are required in each battery, allowing 3 stacked clarifier sets to be out of service. Each clarifier set is made of an upper tank 181 ft in length and 20.5 ft wide, and a lower tank, 191 ft long, also 20.5 ft wide. The lengths for the upper and lower tanks are effective clarification lengths. The area in the lower tank used for flow introduction has been excluded from this length. The minimum sidewater depth of each tank is 12 ft at the effluent end. The tank floors slope down, at a one percent grade, to the influent end of the tanks.

The clarifiers are sized based on an overflow rate of 2000 gpd/$ft^2$ at the peak treatment plant flow of 1270 mgd. For the time period when only primary treatment facilities are operating, all of the flow received at the treatment plant will normally be distributed among the four primary clarifier batteries on an equal basis. However, operators will have the capability to split flow unequally to the four primary clarifier batteries. The clarifiers will operate at overflow rates corresponding to the flow. When the secondary treatment facilities are in operation for the wastewater flow range from minimum flow to 1080 mgd, each of the four batteries of stacked primary clarifiers will normally receive one fourth of the flow and operate at an overflow rate corresponding to this flow. Wastewater flows in excess of 1080 mgd, up to the plant capacity of 1270 mgd, will receive primary treatment and be screened prior to disinfection. In order to produce a superior quality primary effluent for the portion of




NOTES

1. THIS FIGURE IS A PARTIAL PLAN VIEW OF A PRIMARY CLARIFIER BATTERY. THE VIEW IS TAKEN AT AN ELEVATION JUST BELOW THE CLARIFIER COVERS.
2. SECTION A-A IS SHOWN IN FIGURE 11.1.3-18
3. SECTION B-B IS SHOWN IN FIGURE 11.1.3-19
4. DIRECTION OF FLOW IS DESIGNATED BY ARROWS (⟶).

SCALE: 1" = 20'

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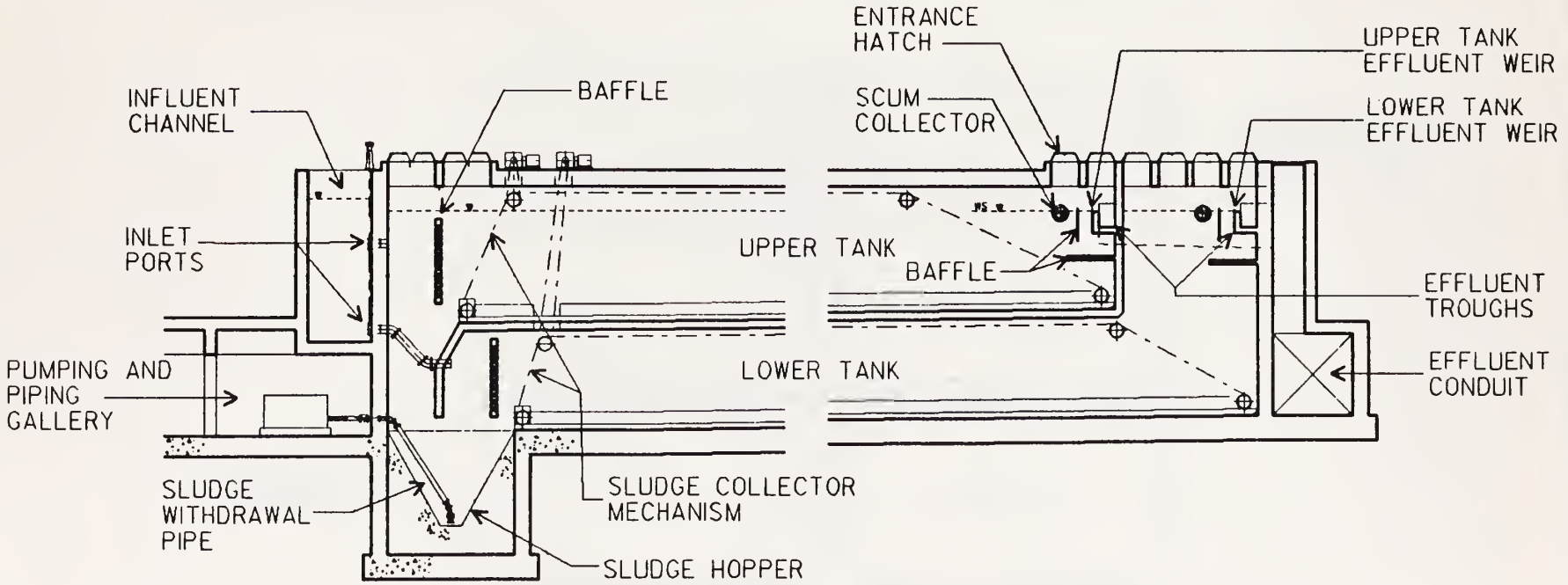
**FIGURE 11.1.3-17**
**STACKED PRIMARY CLARIFIERS**
**PLAN VIEW**




## SECTION A-A

NOTE

1. SEE FIGURE 11.1.3-17 FOR THE PLAN VIEW OF THE PRIMARY CLARIFIERS

SCALE: 1" = 20'

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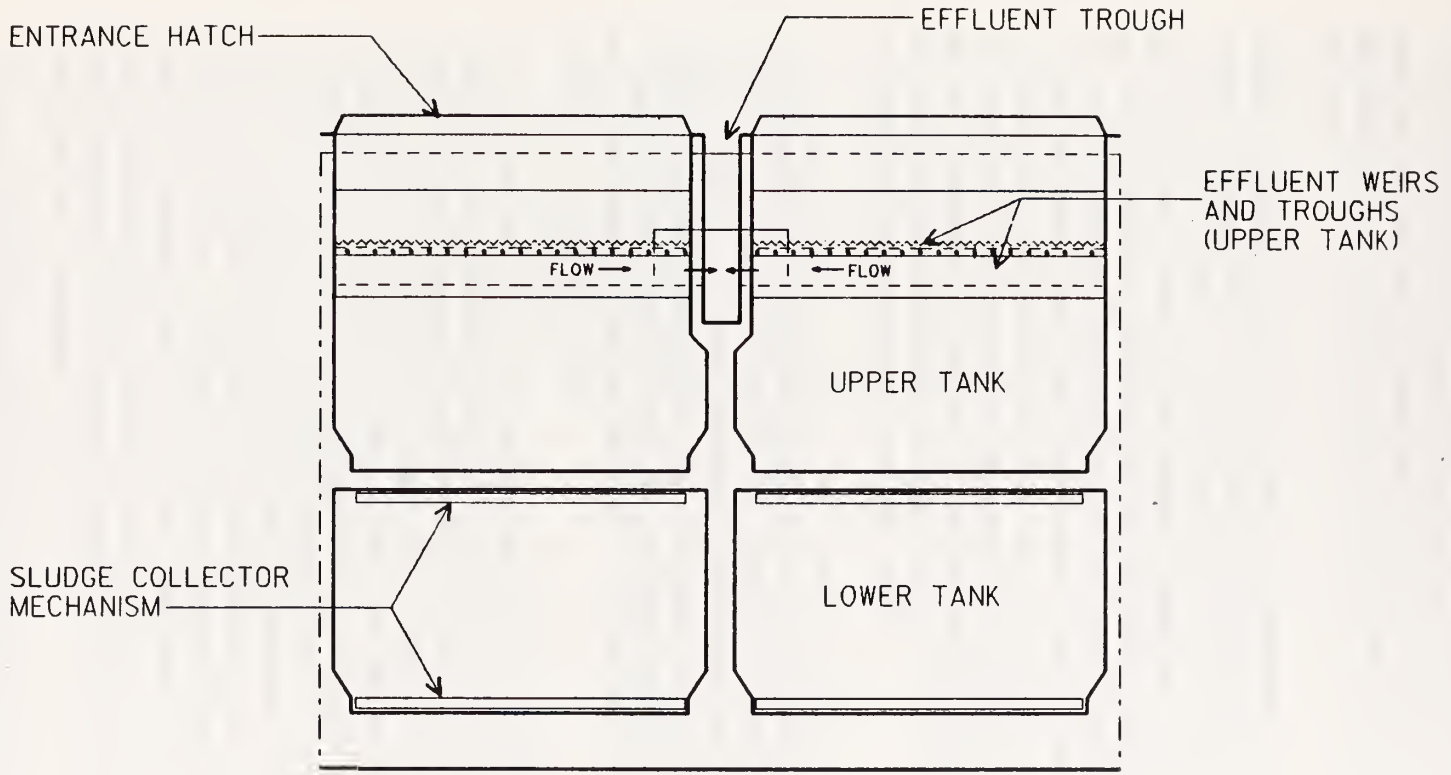
**FIGURE 11.1.3-18**
**STACKED PRIMARY CLARIFIERS**
**LONGITUDINAL SECTION**




## SECTION B-B

SCALE: 1" = 10'

NOTE

1. SEE FIGURE 11.1.3-17 FOR THE PLAN VIEW OF THE PRIMARY CLARIFIERS.

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**FIGURE 11.1.3-19**
**STACKED PRIMARY CLARIFIERS**
**CROSS SECTION**

flow not receiving secondary treatment, the overflow rate in Primary Battery A will be limited to 1200 gpd/sf. The flow diverted to screening would originate from this battery. As a result, the overflow rate in the remaining three batteries increases to 2300 gpd/sf under peak flow conditions. The secondary treatment system has been sized for loads corresponding to this condition.

Efficient operation of the clarifiers requires equal distribution of solids and flow to each clarifier. This distribution will be provided by aerating the influent channel of each battery of clarifiers and providing a controlling headloss into each clarifier. Air will be distributed in the 8.5-ft-wide influent channel by coarse bubble diffusers that are supplied by two 100 hp blowers, each having a capacity of 1600 scfm. One blower will be in operation and one will be on standby. Equal distribution of flow will be controlled hydraulically at clarifier inlet ports located off the influent channel. Flow will enter each stacked clarifier set through four 12-in-diameter inlet ports. Two inlet ports are provided for both the upper and lower tanks. Flow to the upper tank passes directly through the ports into the tank, while the lower tank influent is piped from the inlet ports past the sludge hoppers to the head of the lower tank. This arrangement prevents the lower tank influent flow from interfering with the settling of upper tank solids to the sludge hoppers.

A perforated baffle will be installed on the influent end of each tank to minimize density current formation and ensure flow distribution the width of the tank. As flow passes through the tank, solids settle, producing a clarified effluent. The effluent from the primary clarifiers will flow over V-notch weirs and into effluent troughs for transport to the effluent conduit. The effluent weir troughs, located on the rear end wall of the clarifiers, are 20.5 ft long. The effluent conduit running along the effluent end of the clarifiers increases in size as more clarifiers contribute effluent flow. The maximum size of the effluent conduit for a battery is 9 ft high by 9 ft wide.

The solids that have settled to the bottom of the clarifier are collected by non-metallic longitudinal chain and flight mechanisms which travel counter-current to the flow, moving the solids to the sludge hoppers at the influent end of the tank. Solids are directly withdrawn from the hoppers by sludge pumps located within a pumping and piping gallery that runs along the influent end of the clarifiers. One 120 gpm torque flow sludge pump withdraws sludge sequentially from 2 stacked sets. Twenty pumps, including eight pumps for standby, are provided for one battery. The piping arrangement allows for pumping by any one of the pumps at any time. The piping arrangement also allows for connection to the plant water system for flushing, and isolation of any piping segment for cleaning while maintaining the sludge withdrawal operation. Two plunger pumps are also provided for each battery to assist in relieving any blockages that may occur in the sludge piping system. The estimated quantity of primary sludge that will be generated is 168 tons per day, on an average annual basis. The high groundwater and low groundwater average primary sludge quantities as well as secondary sludge quantities are presented in Table 11.1.3-1.

In addition to removing settleable solids from the wastewater flow, the primary clarifiers also collect floatable material or scum. Scum entering the clarifiers will be scraped to the

**Table 11.1.3-1**

**SLUDGE PRODUCTION**
**DESIGN YEAR 2020**
**(dry tons/year)**

| | Low Groundwater Average | High Groundwater Average | Annual Average |
|---|---|---|---|
| Primary Sludge | 170 | 164 | 168 |
| Secondary Sludge | 144 | 131 | 140 |
| Total | 314 | 295 | 308 |

effluent end of the tanks along the water surface of the upper tank and along the ceiling of the lower tank by the chain and flight sludge collectors. The scum will be removed from the tanks by rotating scum troughs ahead of the effluent weirs. In a battery, the troughs will transport the scum to two 40 hp, 900 gpm torque flow scum pumps for transfer to residuals treatment facilities. Each pump has capacity to pump the estimated peak scum flow. The estimated volume of scum that will be generated from both the primary and secondary clarifiers on an average annual basis is 70 tons per day. Using a peaking factor of 3.0 developed in the Scum Disposal Feasibility Study (1986), up to 210 tons per day may have to be handled.

Air emissions control is provided for the primary treatment facilities. An air flow of 54,700 scfm from the covered primary clarifiers and covered aerated influent channels of Batteries A and B will be treated in the East Air Emission Facility. The same air flow rate from the primary clarifiers and influent channels of Batteries C and D is to be treated in the West Air Emission Facility. The peak air flow rates are based on ventilation rates of 3 air changes per hour for the air space between the water surface and covers of the primary clarifiers and influent channels, and 12 air changes per hour for two stacked clarifier sets per battery that are out of service and require entrance of personnel. The air emissions control facilities are also discussed in this subsection.

For inspection and maintenance purposes, access hatches through the clarifier covers are provided at the influent and effluent ends, and at an intermediate point. Hatches through the floor of the upper tank provide access to the lower tank at the influent end and at the intermediate point. The clarifier configuration allows for direct access to the lower tank in the vicinity of the effluent weirs. When taking one tank out of service for inspection or maintenance, both of the upper and lower tanks must be isolated. Isolation of the tanks is accomplished by closing 12 in by 12 in sluice gates at the inlet ports.

Screening of Primary Effluent

Flows to the secondary treatment facilities are limited to 1080 mgd. Flows in excess of 1080 mgd, up to the primary plant capacity of 1270 mgd, would receive primary treatment and be mixed, after screening to remove floatables, with secondary effluent prior to disinfection. Traveling screens will be used for removing the floatable material from the wastewater flow component not receiving secondary treatment.

Flows in excess of 108 mgd would be discharged to the traveling screens from the effluent end of primary treatment battery A. The operation asociated with the flow discharge were detailed earlier. Wastewater is conveyed by 36-in pipes through a metering facility to a 10 ft by 48 ft trough located inside the screening facility. From here, flow enters the traveling screening bays through 12-ft-wide sluice gates.

To meet the maximum flow of 190 mgd, 2 of the 3 installed six-ft-wide dual flow traveling screens are required. The wastewater enters the screens through the ascending and descending runs and the curved bottom of the screen trays of both runs. The descending run carries the screenings down and around the foot terminal and the ascending run carries the screenings up to

the head terminal for discharge into a trough. The treated flow is discharged through the center of the screen and travels through a 4 ft slide gate, into a 8 ft by 8 ft conduit enroute to the disinfection facility. Figure 11.1.3-20 is a section through the traveling screen showing its main components and the wastewater screening process. Approximately 11 ft of head must be dissipated after screenings prior to disinfection. For costing purposes, it was assumed that flow would discharge over a weir and drop 8 feet into a trough prior to its continuance to the disinfection facility.

The velocity between the nominal 1/4-in screen openings in the screening mesh would be 2 ft/sec at 190 mgd. The screenings which remains on the screens is removed by a high pressure spray wash water. For each screen, about 160 gpm of spray wash water at a pressure between 40 and 80 psi is required at a flow of 190 mgd. For planning purposes, it is assumed that processed plant water will be used as spray wash water. All refuse and the spray wash water are captured in the screenings trough. A 4-in trough is required for each screen. The screenings and the used spray wash water would exit the trough and enter a common 8-inch pipe. It then flows by gravity to a wet well located northwest of the screening effluent conduit and subsequently pumped to Battery A's scum discharge line.

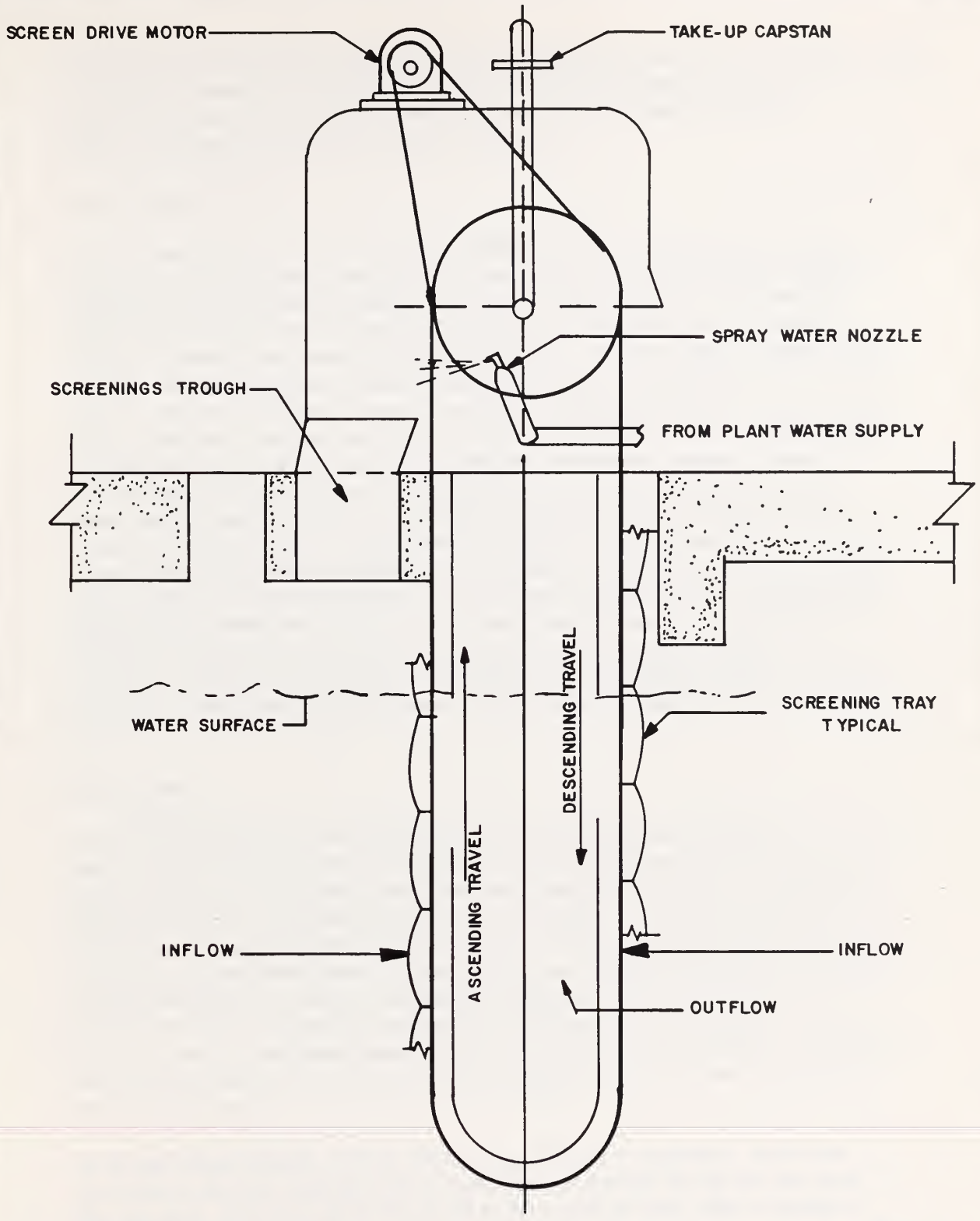
The screening building would be 52 ft by 65 ft and have a height of 30 ft. The use of this building protects the screens and its equipment from inclement weather, mitigates potential odors from conduits and provides housing for odor control equipment. Further, within this building there would be two 2-speed drivemotors for the operation of the screens, and two pumps rated at 350 gpm and a tdh of 25 ft for the operation of the spray wash system. Two torque flow refuse pumps rated at 350 gpm and a tdh of 25 ft would be located in a structure adjacent to the wet well. All equipment including the screens would be automatically controlled and operated from the treatment plant's primary treatment control room. For the purposes of modeling, separate air emissions control equipment has been included within the building. Since the facility will not be used continuously, the option of exhausting room air to another air emission control facility or to the atmosphere should be examined during design.

Secondary Treatment Facilities

The secondary treatment process components consist of an anaerobic selector unit, followed by an oxygen activated sludge system incorporating stacked rectangular clarifiers. This section describes the secondary facilities including unit sizing, equipment requirements, and the flow scheme. The maximum capacity of the secondary treatment facilities is 1080 mgd.

Secondary Splitter Box

After passing through the primary clarifiers, the wastewater from each of the four primary batteries flows through an 9 ft by 9 ft conduit into the secondary splitter box. The splitter box serves to mix and equalize the flows from each of the four primary clarifier batteries for distribution to each of the four secondary batteries. Normally, the flow is split evenly to the four secondary batteries. The operators, however, have the capability to regulate flow to each of the batteries by the adjustment of downstream control gates. The flow to each battery




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.1.3-20 SCREENING FACILITIES - CROSS SECTION |
|---|---|

is measured in each conduit using a venturi with a recording flow range of 35 to 350 mgd. Once flow is split to a battery, it passes sequentially through the selector, aeration basins and clarifiers associated with that battery. There is no capability to transfer or mix flows between secondary batteries past the secondary splitter box.

Anaerobic Selector Basins

From the secondary splitter box the wastewater passes to the four anaerobic selector basins through 9 ft by 9 ft conduits. Return activated sludge (RAS) from the secondary clarifiers is introduced into these conduits through an 7-ft diameter pipeline just prior to the entrance to the selector basins. The use of an anaerobic selector prior to aeration increases process stability by inhibiting the growth of filamentous organisms, which are known to cause sludge bulking. The anaerobic selector basin for each battery measures approximately 130 ft by 180 ft and is divided into four separate covered compartments, each 64 ft by 90 ft by 18 ft sidewater depth. Three feet of freeboard has also been provided. Mixing is provided to maintain solids in suspension, with two 20 hp mechanical mixers per compartment. Baffles provided in the compartments will serve to improve mixing. The ability to vary the detention time in the selector basin is provided by a system of interconnecting sluice gates. The flow can pass through two, three, or all four compartments providing 50, 75, or 100 percent of the maximum detention time. The optimum detention time will be better defined through proposed pilot plant studies of MWRA wastewater and through the evaluation of operational data of plants that are presently under construction or that have just recently become operational using the selector technology. The need for and scope of a pilot plant study is presented in Section 11.1.4. Sizing of the selector basin was based on providing 20 minutes of detention time at 890 mgd, equivalent to average day high groundwater flow plus RAS flow assuming 8000 mg/l solids in the RAS.

Aeration Basins

From the anaerobic selector, the mixed liquor from each battery flows through a 14 ft by 14 ft conduit to the respective covered aeration basin. Each of the four batteries of aeration basins consists of three treatment trains. Each train consists of four stages, each measuring 70 ft by 70 ft by 23.5 ft sidewater depth with 5 ft of freeboard. The resultant total volume under aeration is approximately 41.3 million gallons. Sizing of the oxygen basins was based on maintaining a mixed liquor suspended solids concentration (MLSS) of 2000 mg/l at a solids retention time (SRT) of 2.3 days. This MLSS concentration is less than the 2500 mg/l concentration used to evaluate the alternatives. The refined MLSS concentration was selected based on a review of data from existing oxygen systems operating with low SRT, together with a cost optimizing analysis which indicated that the reduced MLSS level resulted in significantly decreased capital costs.

An aerated influent channel, 14 ft by 128 ft, maintains solids in suspension. Equal flow distribution to the three treatment trains of each battery is provided through the inlet ports. The inlet ports, which have three 30 in by 48 in sluice gates per train, effect a headloss of 1.5 ft under maximum flow conditions. Channel aeration is provided by a coarse bubble diffused

air system. Air is supplied to the influent channel of each battery by a 500 scfm blower with a 20 hp motor. Two blowers per battery, one in operation and one on standby, are located in the secondary sludge pumping station.

Oxygen, at 95 percent purity, is introduced to the head space above the mixed liquor in the first stage of each train. Mechanical surface aerators, with draft tubes, transfer oxygen from the 5 ft head space into the mixed liquor and provide adequate mixing to maintain the solids in suspension. The aeration basins are provided with varying degrees of mechanical aeration as the flow passes through each stage of the train. The tapered power input, 150 hp in the first stage, followed by 100 hp units in the three subsequent stages, permits maximum oxygen transfer in the first stage, and minimum shear in the final stage. From the last oxygen stage the mixed liquor flows into an effluent channel through submerged, gated outlets, over an effluent weir into a 14 ft by 14 ft conduit and then to the respective batteries of secondary clarifiers. Figures 11.1.3-21 and 11.1.3-22 show a plan and section of the anaerobic selector basins and the aeration basins.

Maintenance of the mechanical aerators can be accomplished without draining the aeration basins. The units, mounted on the deck of the basins, can be removed for maintenance with a mobile crane. Access to the basins, if required, is accomplished through a 30-in manway, (one per stage). Should extensive work on the basins be required, additional access can be obtained through the aerator opening, which is approximately 12 ft by 12 ft.

The amount of oxygen fed to the first stage of each train is dependent on the pressure of gas above the mixed liquor. As the oxygen is consumed by the aerobic microorganisms, the gas pressure decreases. A differential switch senses the pressure drop and actuates a valve that will allow more gaseous oxygen into the reactor.

The oxygen system is provided with localized sensors that detect hydrocarbons in the head space in the first and fourth stage of the reactor. Should hydrocarbon levels increase to an unsafe, preset level, usually about 25 percent of the lower explosive limit, an alarm sounds, the oxygen feed stops, and purge blowers evacuate the head space in the tanks. When hydrocarbon levels decrease, oxygen feed is resumed. Two 10,000 scfm purge blowers per battery are provided, each capable of purging the oxygen in the head space in one hour. The purge blowers are located on the deck of the first stages of each aeration battery. The hydrocarbon sensors are calibrated weekly and the purge blowers are operated monthly to ensure proper operation of the system. The Passaic Valley, NJ, oxygen activated sludge plant, which serves a combined system in an industrial area, also utilizes such a purge system. It is reported that the purge system has operated infrequently since primary treatment went on-line.

Cryogenic Oxygen Generation

Oxygen for the activated sludge system will be provided by cryogenic oxygen generators. The cryogenic air separation process involves compressing and cooling feed air until liquification occurs, removing impurities by low pressure condensation, then separating the oxygen from the air by fractional distillation. Figure 11.1.3-23 schematically shows a cryogenic oxygen

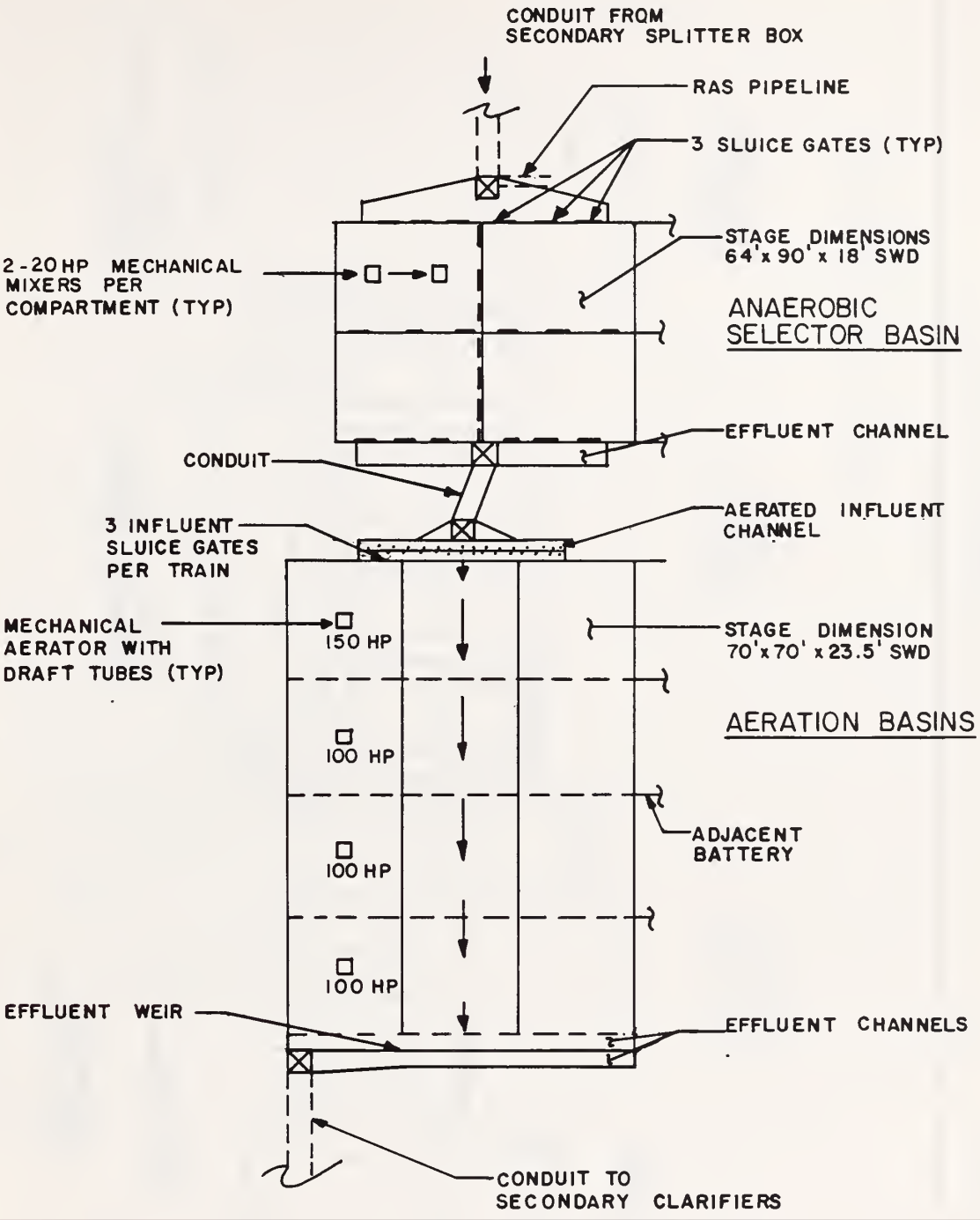



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**FIGURE 11.1.3-21**
**ANAEROBIC SELECTOR AND AERATION BASINS - PLAN**

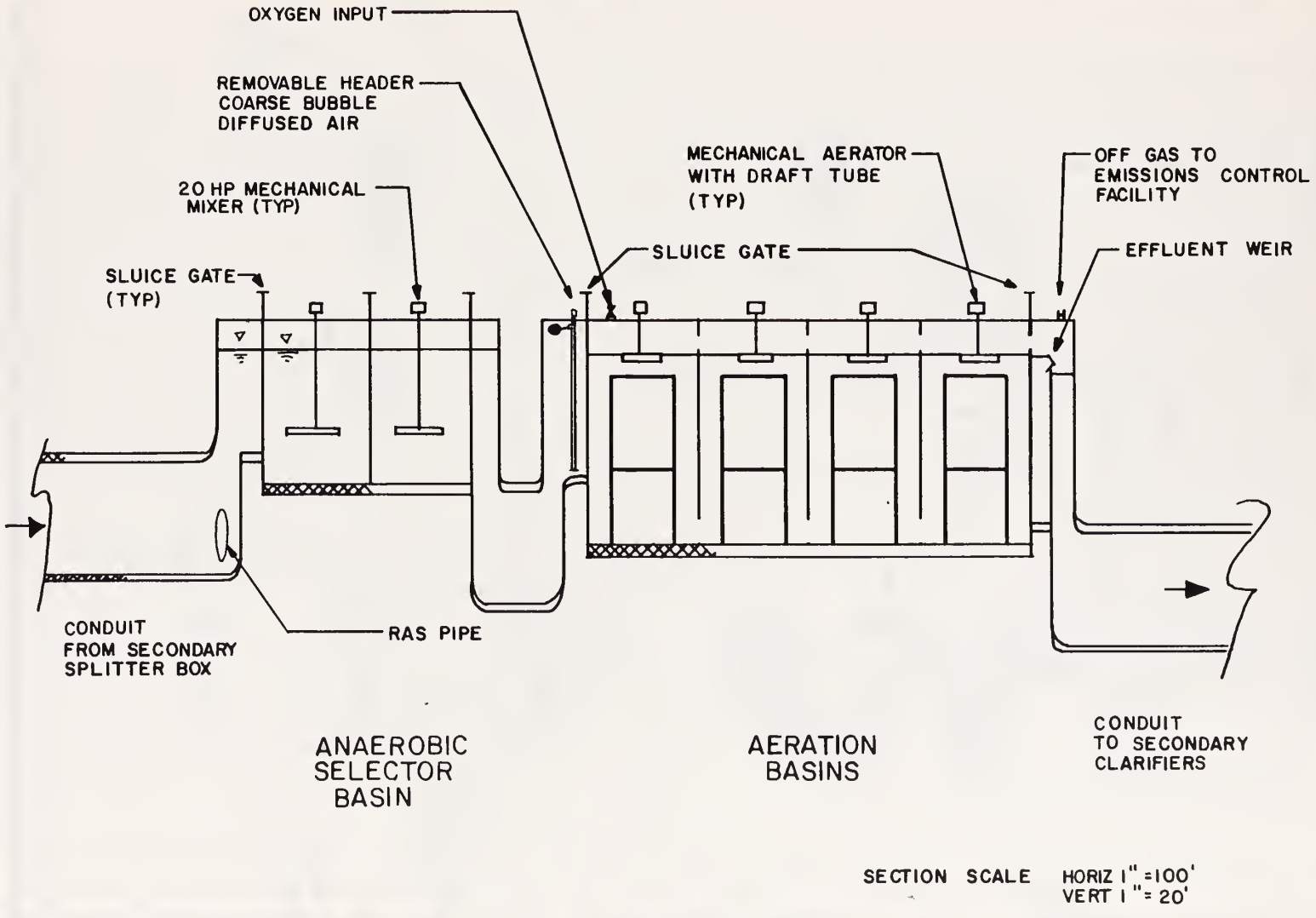


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**FIGURE 11.1.3-22**
**ANAEROBIC SELECTOR AND AERATION BASINS - SECTION**

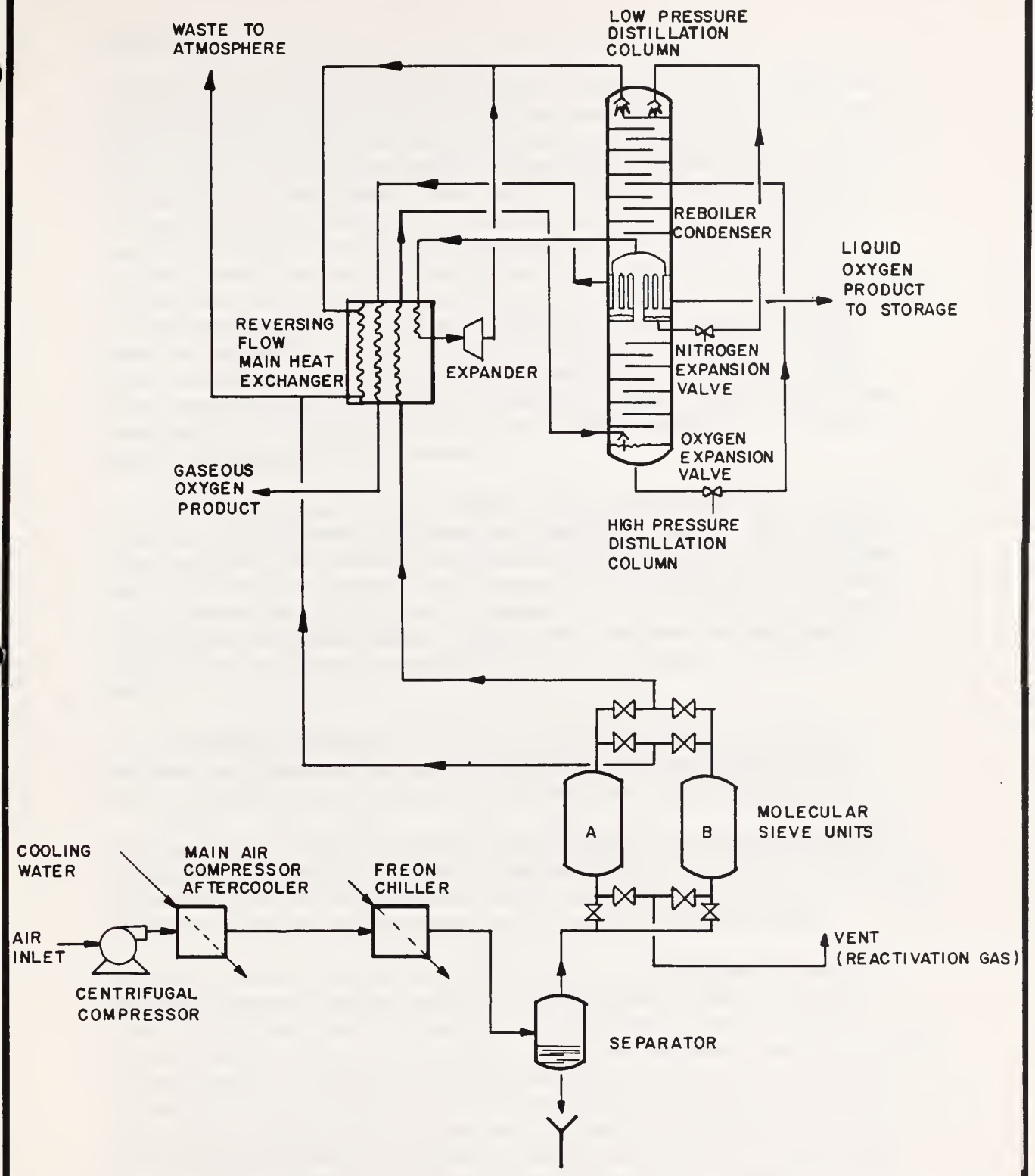


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**FIGURE 11.1.3-23**
**SCHEMATIC OF CRYOGENIC OXYGEN GENERATION PLANT**

generator.

Atmospheric air, for all practical purposes, consists of a mixture of 79 percent nitrogen and 21 percent oxygen by volume, plus carbon dioxide and water vapor. Atmospheric air is drawn into the system by centrifugal compressors. Air filtration and inlet silencers are provided. The air stream is cooled as it passes through the freon chillers, to temperatures so low that the water vapor and carbon dioxide in the air solidify. Most of the impurities are removed by condensate traps following the chiller. The remaining water vapor and carbon dioxide are removed by passing the air stream through molecular sieve units. The molecular sieve prepurifier removes water and carbon dioxide from the air by adsorption onto a crystalline molecular sieve medium. The flow passes through the reversing flow heat exchanger, and oxygen is separated from the clean, cold air in the low pressure distillation column. This method utilizes the difference in boiling points of oxygen and nitrogen. Since oxygen has a higher boiling point than nitrogen, when heat is applied to the liquified air, the nitrogen is driven off as a vapor leaving the oxygen behind in the liquid state. Gaseous oxygen is drawn off the system just above the liquid oxygen. Liquid oxygen can also be extracted from the system and stored for use during peak oxygen demands.

Two 300 ton per day cryogenic oxygen generators will be provided at Deer Island. Only one unit is required under peak conditions; the other unit is available as a standby. Two centrifugal compressors rated at 100 percent capacity (3500 hp) and two compressors rated at 70 percent capacity (2500 hp) will be provided. Each compressor has the ability to serve either cryogenic oxygen generation unit. For this system two molecular sieve units, approximately 25 ft by 35 ft by 35 ft high, will be located outside, adjacent to the two distillation columns housed in separate insulated cold boxes approximately 15 ft by 15 ft, and standing approximately 80 ft high.

A control building, approximately 70 ft by 140 ft, houses the compressors, air filtering equipment, and electrical equipment as well as the control center that includes an office, control room, analyzer room, locker rooms, lunch room, and storage and maintenance areas.

A cooling system required for each cryogenic oxygen generation plant requires the circulation of approximately 1.75 mgd of water. Two cooling water recycle pumps for each system (including one standby unit) are required, each with a 1200 gpm capacity driven by a 15 hp motor. Between 90,000 and 180,000 gpd of potable makeup water is required for the cooling system.

Each oxygen generation plant has the capability to operate over a range from full capacity to 50 percent of the rated production capacity. The production range available is, therefore, from 150 to 300 tons per day. If oxygen requirements fall below the minimum production level, then oxygen must be wasted to the atmosphere. When oxygen requirements exceed the production capacity of the plant, additional oxygen requirements are met through the use of stored liquid oxygen (LOX). LOX is produced by the cryogenic oxygen generation plant at a rate equivalent to between about 5 and 15 percent of the total oxygen generation plant capacity per day, or 15 to 45 tons per day. LOX storage of 1000 tons has been provided. This is sufficient to handle demands in excess of gaseous oxygen capacity, annual cryogenic plant turnaround, and LOX

requirements in the event of unscheduled plant downtime. Evaporative losses in LOX storage approximates 0.2 to 0.3 percent of the total LOX storage, or 2 to 3 tons per day.

The transmission of gaseous oxygen from the generation area to the oxygen basins will be above grade through a looped 18-in carbon steel pipe with welded joints. The maximum transmission distance is approximately 1500 ft, which should not require any special design considerations to maintain adequate pressure in the line.

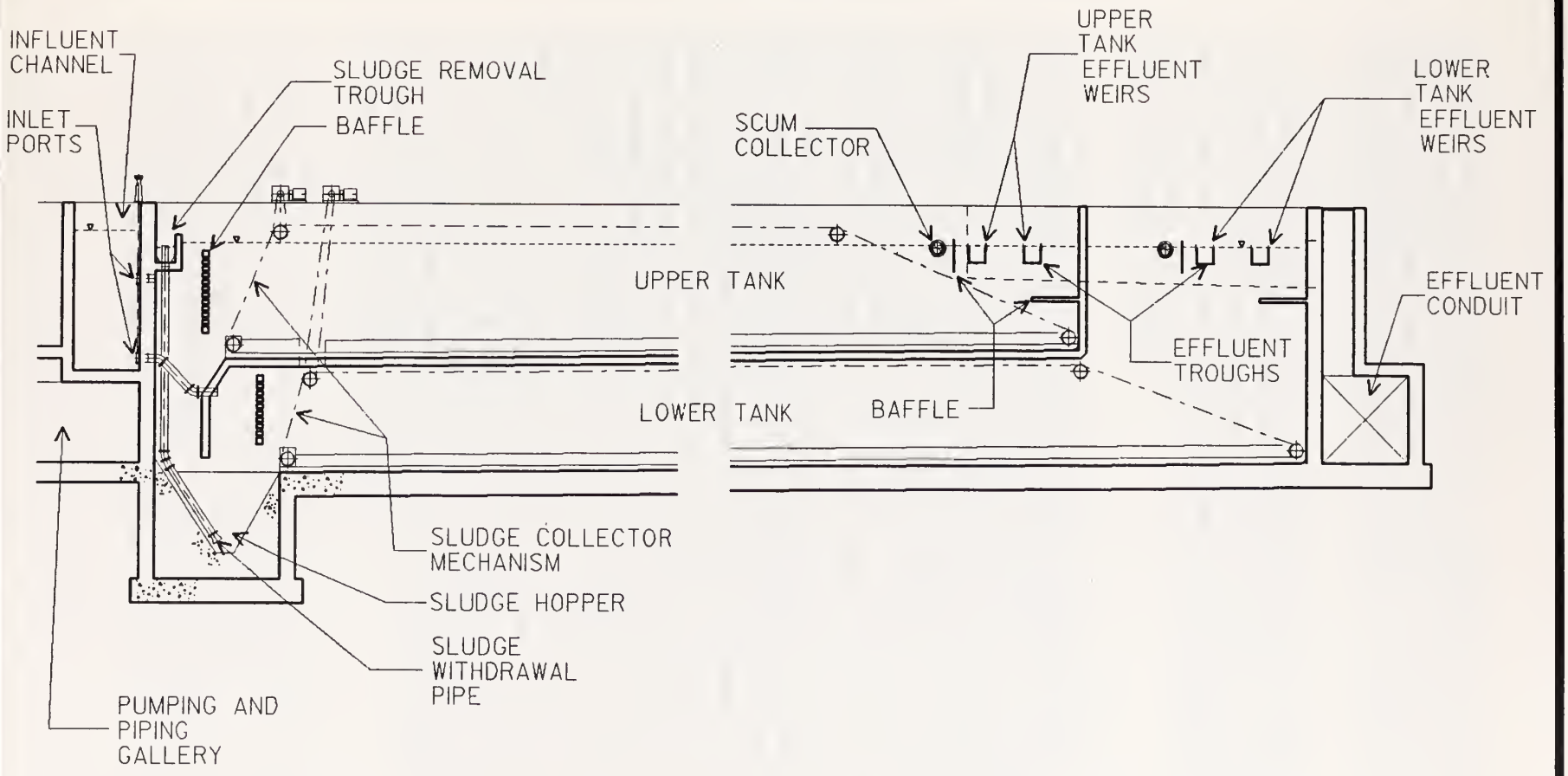
Annually, the cryogenic oxygen generation plant requires an overhaul that can best be accomplished through a service contract with the manufacturer. During the overhaul period, the plant which has been on-line is taken out of service and the second plant is brought on-line. Bringing the second plant into operation requires three to four days to establish the proper temperature in the system. This time can be reduced to one or two days if liquid oxygen is used during start-up. For start-up assistance, approximately 70 percent of the rated gaseous capacity of cryogenic plant (210 tons) is required in the form of LOX for start-up assistance.

Storage of LOX on-site requires special considerations. Although oxygen is not flammable, it more readily supports ignition and combustion of materials, in comparison to air. Liquid oxygen must be stored in a well-ventilated area to avoid the collection of oxygen (which is heavier than air) in the event of system leaks. There will be controlled access to this area. Cryogenic oxygen generation has been utilized in municipal treatment works for a number of years and has a clean safety record.

Secondary Clarifiers

The effluent from each battery of the aeration basins passes through a 14 ft by 14 ft conduit to its respective battery of stacked rectangular secondary clarifiers, where the mixed liquor suspended solids settle, producing a clarified effluent. The stacked secondary clarifiers operate in the same manner as the stacked primary clarifiers discussed previously. Each clarifier consists of two tanks, one directly above the other. The secondary clarifiers are not covered. However, the clarifiers should be designed to facilitate the future installation of covers if this should be deemed desirable. The clarifiers are arranged in four batteries of clarifiers, each battery consisting of 36 stacked clarifiers. Under peak flow conditions, 32 clarifiers per battery are required, allowing 4 clarifiers per battery to be out of service. The lower tank of a clarifier is 180 ft long by 20.5 ft wide and the upper tank is 160 ft long by 20.5 wide. These lengths are effective lengths, thus the area associated with inlet piping in the lower clarifier has not been included. The minimum sidewater depth in both cases is 13 ft at the effluent end. The tank bottoms slope to the influent end at a 1 percent grade. Figure 11.1.3-24 shows a typical section of the stacked secondary clarifier.

In order to maintain equal solids and flow distribution into each clarifier, each battery is equiped with two aerated influent channels, with each channel serving eighteen clarifiers. These channels, 420 ft long by 8.5 ft wide, are aerated with coarse bubble diffused air at a rate of 3 scfm per linear ft. Air will be supplied through a blower, sized at 2600 scfm with a 150 hp motor. Two blowers are provided, one in operation and one in standby. The upper and




SCALE: 1" = 20'

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**FIGURE 11.1.3-24**
**STACKED SECONDARY CLARIFIERS**
**LONGITUDINAL SECTION**

lower tanks operate on a common water surface. Flow distribution to each tank from the influent channels is controlled through two 10-in-diameter ports, four ports per stacked set. Each clarifier is fed independently, resulting in parallel flow through the upper and lower tank. So as not to disrupt the settling sludge in the upper tank, the influent to the lower tank is piped beyond the sludge hopper.

A perforated baffle located at the influent end of each tank serves to minimize density currents and ensure even flow distribution at the head of the tank. As the flow passes through a tank, the mixed liquor solids settle, producing the clarified effluent. The effluent from both the upper and lower tanks flow over V-notched weirs into two transverse effluent troughs. The total weir length is 82 ft per tank. The troughs feed into the effluent conduit which conveys the effluent to disinfection.

The activated sludge system preceded by the anaerobic selector is expected to produce a superior settling sludge with a sludge volume index (SVI) less than 150 ml/g. Because of this, an overflow rate of 750 gpd/sf at the average high groundwater flow of 670 mgd was used to size the secondary clarifiers. This corresponds to a peak overflow rate of 1200 gpd/$ft^2$. The solids loading rate at 8000 mg/l solids in the RAS and at a high groundwater average daily flow of 670 mgd is 17 lb/d $ft^2$ and at low groundwater average daily flow of 390 mgd is 10 lb/d $ft^2$. The settled solids in the clarifiers are collected by longitudinal non-metallic chain and flight mechanisms moving counter-current to the flow. Solids are moved to common hoppers at the influent end of each stacked set of clarifiers. Sludge is withdrawn from the hoppers by gravity through motorized telescopic valves to a trough at the top of the clarifiers that allows operators to view the withdrawn sludge. The withdrawal rate of sludge from the clarifiers is controlled by the elevation differential between the clarifier water surface and the pumping station wet well water surface in the trough. Adjustments in flow between sets of stacked clarifiers can be made using the telescopic valves. The sludge is then conveyed by gravity to a secondary sludge pumping station. Overall withdrawal rate is set by the RAS pumps to the secondary sludge pump station. One pumping station is provided for each of the four clarifier batteries. The pumping station for each battery consists of five RAS pumps, 30,000 gpm each, with 300 hp variable speed motors, and five WAS pumps. In both cases, 3 pumps are required for peak flow and 2 pumps serve as standby. The RAS pumps are set up to allow the plant to operate as four separate batteries or two separate plants. The RAS in battery A can be intermixed with the RAS in battery B by opening sluice gates between battery A and battery B wet wells. The same type of intermixing can be accomplished between batteries C and D. Also, sludge can be moved from batteries A & B to C & D, or vice versa, via the use of the waste activated sludge pumps discharging to the opposite wet wells. The estimated quantity of WAS generated was presented previously in Table 11.1.3-1.

Scum and floating material in the secondary clarifiers will be scraped to the effluent end of the tank, along the water surface of the upper tank, and along the ceiling of the lower tank by the chain and flight sludge collectors. Scum removal is provided prior to the effluent weirs through rotating scum troughs. The removed scum flows by gravity into a scum wet well for pumping to the residual treatment process. A total of sixteen 700-gpm scum pumps with 40 hp motors are required. Eight of the pumps are required to pump the anticipated peak flow. The estimated volume of scum that will be generated from both the primary and secondary clarifiers

on an average annual basis is 70 tons per day.

Common wall construction allows for the draining of one stacked set of clarifiers without disrupting flow through adjacent sets. Isolation of the tanks is accomplished by closing 10-in by 10-in sluice gates at the inlet port. The tank arrangement allows for direct access into the lower tank in the vicinity of the effluent weirs. Hatches through the floor of the upper tank provide access to the lower tank at the influent end and at an intermediate point.

For additional information regarding the operational data and selection of the stacked secondary clarifiers, refer to Appendix M.

Air Emissions

Operations and process areas requiring air emissions control facilities in the secondary treatment process include: the secondary splitter box; the anaerobic basins selector including influent and effluent channels; the aerated influent channel to the aeration basins; the off-gas from the aeration basins; and the aerated influent channels to the secondary clarifiers. The total airflow requiring treatment under peak conditions is 39,000 scfm of which 6000 scfm is from the aeration basins. Due to plant configuration, two facilities have been provided, each with the capacity to treat one-half of the design air flow from each battery or 18,000 cfm.

One facility will have the additional capacity to take air emissions from the secondary splitter box of 3000 cfm. In the design of emissions control for the oxygen basins, it is important not to upset the oxygen pressures in the aeration basins, since oxygen supplied to the system is pressure sensitive. The air emissions control facilities are discussed in this Section, 11.1.3.

Table 11.1.3-2 summarizes the expected operation of the oxygen activated sludge system.

Disinfection

The disinfection facilities consist of four contact basins, an on-site storage system to receive barge deliveries of sodium hypochlorite, and a hypochlorite feed system including a chlorine residual analyzer system. Space has been provided in the recommended layout to include the addition of sodium metabisulfite at the chlorine contact basin effluent channel for dechlorination, should the results of whole effluent toxicity testing of the pilot plant effluent indicate that dechlorination is required. The sodium metabisulfite would be barged to the facilities' location and stored on-site, and would be mixed with the effluent just prior to discharge into the outfall tunnel shaft.

The disinfection facilities have been sized to provide for fifteen minutes detention time at peak flow with all four contact basins in use. The storage requirements have been sized to provide adequate chemicals for the disinfection needs associated with a primary effluent.

## Table 11.1.3-2

## OXYGEN ACTIVATED SLUDGE SYSTEM
## OPERATION SUMMARY DESIGN YEAR 2020

| | Low Groundwater | | | | High Groundwater | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum Day | Average Day | Maximum Day | Storm | Minimum Day | Average Day | Maximum Day | Storm |
| Flow to Secondary Treatment (mgd) | 320 | 390 | 600 | 1080 | 600 | 670 | 950 | 1080 |
| BOD to Secondary Treatment (1000 lb/day) | 293 | 408 | 826 | 914 | 395 | 433 | 886 | 960 |
| Anaerobic Selector Basin Maximum Detention Time (minutes) | 42 | 34 | 22 | 12 | 22 | 20 | 14 | 12 |
| Aeration Basin | | | | | | | | |
| Volume (mil. gal.) | 41.3 | 41.3 | 41.3 | 41.3 | 41.3 | 41.3 | 41.3 | 41.3 |
| Detention Time (hr) | 3.1 | 2.5 | 1.7 | 0.9 | 1.7 | 1.5 | 1.0 | 0.9 |
| MLSS (mg/l) | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| MLVSS (mg/l) | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 |
| F/M ($day^{-1}$) | 0.5 | 0.7 | 1.4 | 1.4 | 0.7 | 0.7 | 1.4 | 1.5 |
| $0_2$ Supplied (tpd) | 125 | 175 | 355 | 370 | 165 | 175 | 360 | 390 |
| Soluble Effluent BOD | 6 | 6 | 15 | 15 | 6 | 8 | 15 | 15 |
| Secondary Clarifiers | | | | | | | | |
| Surface Area (sf) | 892,160 | 892,160 | 892,160 | 892,160 | 892,160 | 892,160 | 892,160 | 892,160 |
| Overflow Rate (gpd/sf) | 359 | 437 | 684 | 1211 | 673 | 750 | 1076 | 1211 |
| RAS Flow at 8000 mg/l (mgd) | 107 | 130 | 203 | 360 | 200 | 223 | 320 | 360 |
| Solids Loading Rate | 8 | 10 | 15 | 27 | 15 | 17 | 24 | 27 |

There is sufficient storage to provide disinfectant for a primary effluent for 8 days of maximum day high groundwater conditions flow of 950 mgd. The chemical feed system consists of 13 metering pumps.

The regulatory requirement for a delivery capacity of 25 mg/liter at average high groundwater condition flows requires 11 metering pumps in service.

The sizing of storage facilities and chemical feed systems has been based upon the chlorine demands of primary effluent. With secondary effluent the chlorine demand will drop and there will be a redundancy of equipment associated with disinfection. In addition to the disinfection needs of the effluent there are other incidental needs for disinfecting chemicals associated with plant water, odor control, and return activated sludge bulking control. These needs will be supplied from the storage facilities.

The recommended chlorine contact tanks are sited at the northeastern side of the facility between the outfall shaft to the north, the secondary clarifiers Battery B to the west, and the aeration basins Battery B to the south. The tankage consists of four basins, each basin containing 930 linear ft of 20-ft-wide uncovered channel with a depth of 24 ft. The channel is arranged in serpentine fashion with a total of three passes.

The sodium hypochlorite is dosed by diffusers located at the head end of the basins. Flow into the basins is controlled by four sluice gates each with a clear opening of approximately 25 $ft^2$.

Connections for the basin drainage system and intake pipes for the plant water system are located at the end of the second pass, and at the start of the third serpentine pass adjacent to the head end of the basins. These piped connections pass through to an abutting pipe gallery area that houses the plant water system as well as the sodium hypochlorite and sodium metabisulfite metering pumps.

At the tail end of the third pass are located the outlet weirs which have been configured as side weirs 40 ft long, four per basin, totaling 160 ft. The chlorine residual analyzer intakes will be located immediately upstream of the weirs. The basins will discharge into an effluent collection channel that will serve as the dosing channel for dechlorination if necessary.

The chemical storage tanks are 250,000 gallon capacity tanks constructed of either concrete or steel with an epoxy or polyethelene lining for corrosion resistance. A total of 6 tanks are recommended, three for sodium hypochlorite, two for sodium metabisulfite, and one as a spare. The tanks are 40 ft in diameter and 30 ft high and are surrounded by a containment dike to control spillage, valve failure, or tank leakage. The tanks are connected to the pier facility by two pipe lines twelve inches in diameter.

Air Emission Control Facilities

Facilities that will require odor and VOC control systems include the new Nut Island headworks and the following facilities on Deer Island:

- North Main Pumping Station Tunnel Vent Shafts
- Winthrop Terminal
- South System Pumping Station Wet Wells
- Deer Island Grit Removal Facilities
- Grit Handling Building
- Primary Wastewater Treatment
  - splitter box
  - influent channels
  - primary clarifiers
- Primary Screening Building
- Secondary Wastewater Treatment
  - splitter box
  - anaerobic selectors
  - aeration basins
  - secondary clarifier influent channels
  - return activated sludge wet well vents

Preliminary sizing for these facilities was based on a ventilation rate of twelve air changes per hour for occupied spaces, and three air changes per hour for unoccupied spaces. Occupied spaces include the Winthrop Terminal, the grit chambers, and the grit handling and screening buildings. Exhaust air volumes for the aerated primary and secondary inlet channels, and for the secondary aeration tanks, were based on the actual air volume (oxygen for aeration tanks) introduced to the process.

In addition to normal ventilation, a maintenance ventilation volume was included for the primary clarifiers. The maintenance system allows for up to four primary clarifiers to be out of service for maintenance. During this time, these tanks would be vented at twelve air changes per hour. Maintenance ventilation is also considered for the North Main and South System pumping station's wet wells.

Table 11.1.3-3 lists the estimated exhaust air volumes and required air emission control equipment for the Deer Island wastewater treatment facility and the Nut Island headworks. Because of the large distances between treatment processes at Deer Island, six odor/VOC control facilities are required.

Based on typical values from other wastewater treatment plants, the average uncontrolled odor emission rate from all wastewater processes was estimated to be 15 ppm hydrogen sulfide. The selected control system, scrubbing followed by carbon adsorption, will remove 95 to 99 percent of the hydrogen sulfide from the air stream.

Table 11.1.3-3
DESCRIPTION OF AIR EMISSION CONTROL FACILITIES

| Location | System Capacity | No./Size of Packed Tower Scrubbers | No./Size of Dual Bed Carbon Adsorbers | No./Size of Exhaust Fans | Building Size |
|---|---|---|---|---|---|
| Winthrop Terminal | 15,300 scfm | (2) 6 ft diameter | (2) 12 ft diameter | (2) 15,300 scfm | 50 ft x 80 ft x 28 ft height |
| East Air Emission Control Complex: | -- | -- | -- | -- | 85 ft x 150 ft x 30 ft height |
| Grit Chambers | 19,000 scfm | (2) 6 ft diameter | (2) 12 ft diameter | (2) 19,000 scfm | -- |
| Grit Handling Bld. | 21,000 scfm | (2) 7 ft diameter | (2) 12 ft diameter | (2) 21,000 scfm | -- |
| Primary Clarifiers | 39,800 scfm | (2) 9 ft diameter | (2) 12 ft diameter | (2) 39,800 scfm | -- |
| Clarifier Maint. | 22,100 scfm | (1) 7 ft diameter | (1) 12 ft diameter | (1) 22,100 scfm | |
| West Air Emission Control Complex: | -- | -- | -- | -- | 80 ft x 125 ft x 30 ft height |
| Grit Chambers | 19,000 scfm | (2) 6 ft diameter | (2) 12 ft diameter | (2) 19,000 scfm | -- |
| Primary Clarifiers | 32,600 scfm | (2) 8 ft diameter | (2) 12 ft diameter | (2) 32,600 scfm | -- |
| Clarifier Maint. | 22,100 scfm | (1) 7 ft diameter | (1) 12 ft diameter | (1) 22,100 scfm | -- |
| Screening Building | 21,000 scfm | (2) 7 ft diameter | (2) 12 ft diameter | (2) 21,000 scfm | 60 ft x 75 ft x 28 ft height |
| Secondary Treatment (East) | 21,000 scfm | (2) 7 ft diameter | (2) 12 ft diameter | (2) 21,000 scfm | 50 ft x 80 ft x 28 ft height |
| Secondary Treatment (West) | 18,000 scfm | (2) 5 ft diameter | (2) 12 ft diameter | (2) 18,000 scfm | 50 ft x 80 ft x 28 ft height |
| Nut Island Headworks | 55,000 scfm | (3) 7 ft diameter | (4) 12 ft diameter | (4) 27,500 scfm | 65 ft x 100 ft x 20 ft height |

The majority of the VOCs will be removed by carbon adsorption. The activated carbon is capable of removing 70 to 90 percent of the VOCs from the air stream. After the activated carbon has been saturated with VOCs, desorption is required. Desorption with nitrogen or air would be accomplished approximately weekly. The desorbed VOCs will be treated in a fume incinerator located at each air emission control facility and designed to achieve 99.99 percent destruction of VOCs. Yearly, the carbon would be removed, transported to an off-site facility for direct thermal regeneration, then returned for use.

Each odor/VOC control facility will consist of wet scrubbers followed by carbon adsorption units. The exhaust air is drawn through the units by fans and the treated air is discharged through a stack to the atmosphere. The equipment includes 5 to 9-ft-diameter packed tower scrubbers, exhaust fans and 12-ft-diameter dual bed carbon adsorbers. Under normal operation, one scrubber, fan and carbon adsorber are provided as standby. Since the oxygen supplied to the aeration basins is dependent on the pressure in the tanks, the two secondary treatment air emissions control facilities must be designed to avoid upsetting the oxygen pressure in the basins.

Plant Utilities

Power and Heat Summary

A study was performed to evaluate primary and backup energy supply alternatives to provide the requisite electrical power to Deer Island in support of facility construction and operation. A complete presentation of the power study, is contained in Appendix H to this volume. This section summarizes that power study.

Currently, no public electric utility service exists at the Deer Island wastewater treatment facility. All electrical energy currently consumed at the facility is self-generated onsite by five, 700 kw diesel engine-driven generators. In addition, all but one of the existing influent pumps at the Main Pumping Station are diesel engine-driven. As part of the ongoing Fast Track Improvement Program, four additional influent pumps are being electrified. To support this conversion, two additional 6,000 kw diesel engine-driven generators are being installed and should be in operation by late 1988.

The electric power required for the period of 1986 to 1999 and beyond for the combined construction activities and wastewater treatment operations on Deer Island associated with Fast Track Improvements, Pier Facilities, Interim Sludge Disposal, Full Primary and Secondary Treatment, and Residuals Management, is summarized in Table 11.1.3-4. Based on these needs, alternative ways to satisfy the energy requirements through a combination of onsite generation and offsite supply were evaluated, and a plan of action was recommended. Based on currently available information and assumptions, the recommended action plan is believed to offer the most cost-effective approach, although steps may have to be taken to re-establish implementation priorities based upon the availability of off site power supply from BECo in 1992. Implementation of the recommended plan for providing sufficient reliable power to Deer Island currently consists of the following steps:

## TABLE 11.1.3-4

## PRELIMINARY POWER NEEDS OF SECONDARY TREATMENT FACILITIES PLAN

| Year | Description of power needs | Average load (kW) period | Cumuative average load (kW) | Peak load (kW) period | Cumulative peak load (kW) | Cumulative installed capacity (kW) | Cumulative secure capacity (kW) | Cumulative *shortfall (kW) |
|---|---|---|---|---|---|---|---|---|
| 1986 | One electrified influent pump | 1,500 | | 1,500 | | 3,500 | 2,800 | |
| | Basic power usage | 650 | | 650 | | | | |
| | | | 2,150 | | 2,150 | 3,500 | 2,800 | 0 |
| 1988 | Electrification of four additional influent pumps and Winthrop terminal pumps | 2,500 | | 7,200 | | 12,000 | 6,000 | |
| | | | 4,650 | | 9,350 | 15,500 | 8,800 | 550 |
| 1990 | Construction power | 10,000 | | 15,000 | | -----0 | -----0 | |
| | | | 14,650 | | 24,350 | 15,500 | 8,800 | 15,550 |
| 1991 | Piers, primary sludge dewatering, and basic power | 4,000 | | 4,500 | | -------0 | -----0 | |
| | | | 18,650 | | 28,850 | 15,500 | 8,800 | 20,050 |
| 1995 | Primary treatment and basic power usage; | 7,800 | | 9,400 | | | | |
| | Electrification of five influent pumps, Winthrop terminal pumps and South System flows; | 4,100 | | 17,700 | | | | |
| | Air emissions control; | 500 | | 1,250 | | | | |
| | Construction power | -7,000 | | -12,000 | | -3,500 | -2,800 | |
| | Enterprise engines retired | | 24,050 | | 45,200 | 12,000 | 6,000 | 39,200 |
| 1999 | Secondary facilities and basic power usage | 13,500 | | 19,400 | | | | |
| | Additional air emissions control; | 250 | | 625 | | | | |
| | Sludge process; | 2,000 | | 2,000 | | | | |
| | Construction power | -3,000 | | -3,000 | | | | |
| | | | 36,800 | | 64,225 | 12,000 | 6,000 | 58,225 |

*Secure capacity is that capacity which because it is provided from two separate sources is considered to be totally reliable in accordance with EPA technical criteria as specified in EPA Technical Bulletin EPA - 430-99-74-001.

1. Complete installation of an immediate, but interim, power supply from MECo's Winthrop grid by January 1, 1990 or sooner;

2. Complete installation of the first 115 kv permanent feeder from K Street, South Boston, by January 1, 1992;

3. Complete installation of a combined cycle power plant by January 1, 1995;

4. Complete installation of the second 115 kv permanent feeder from Chelsea by January 1, 1995.

These implementation steps are further defined below.

Immediate Power Supply. Boston Edison Company (BECo), will provide 15 MW of immediate, but interim, power through a fringe agreement with Massachusetts Electric Company. Massachusetts Electric Company (MECo) proposes to provide this power from its Metcalf Square Substation in Winthrop via a 24 kVA cable routed as shown on Figure 11.1.3-25. BECo will be responsible for delivering this energy to the proposed Deer Island wastewater treatment facility substation from the property line.

Planning activities to date have identified the potential availability of only 15 MW of immediate power. Discussions, however, are continuing to determine the maximum amount of energy available from Massachusetts Electric Company during the 1989 to 1995 period. In any case, this immediate power will be available only until 1995, at which time MECo will require this energy to serve its other customers.

115 kv Permanent Feeders. The source of the first 115 kv feeder to be installed by 1992 will be BECo's K Street Substation. The second 115 kv cable installed by 1995 will be routed from Chelsea.

The K Street feeder will be routed primarily under Boston Harbor to Deer Island. The cable were have four conductors for reliability purposes. The cable from Chelsea will be routed through East Boston across Logan Airport and then under the Harbor to Deer Island.

BECo has indicated that the permitting activities for implementation of both feeders may be severe. They have advised that the total schedule duration for permitting, engineering, designing and constructing the first feeder from K Street will be about 48 months. Based on this 48 month implementation schedule, an inservice date for the first feeder from K Street could be as early as the end of 1991. BECo has also advised that approval of their second feeder's routing across Logan Airport will be even more time consuming. Thus, the two feeders will most likely be constructed one after the other, rather than in parallel efforts.

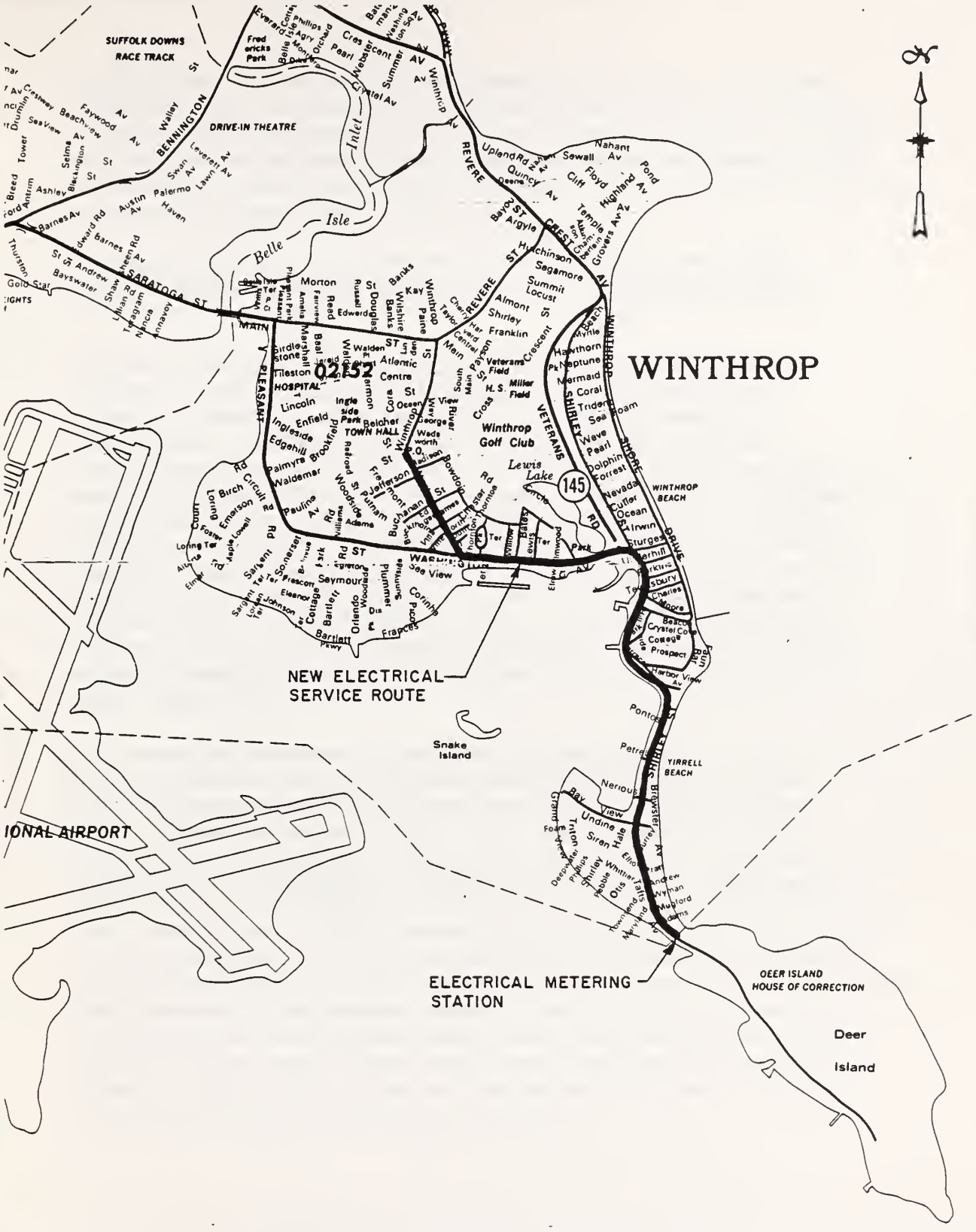


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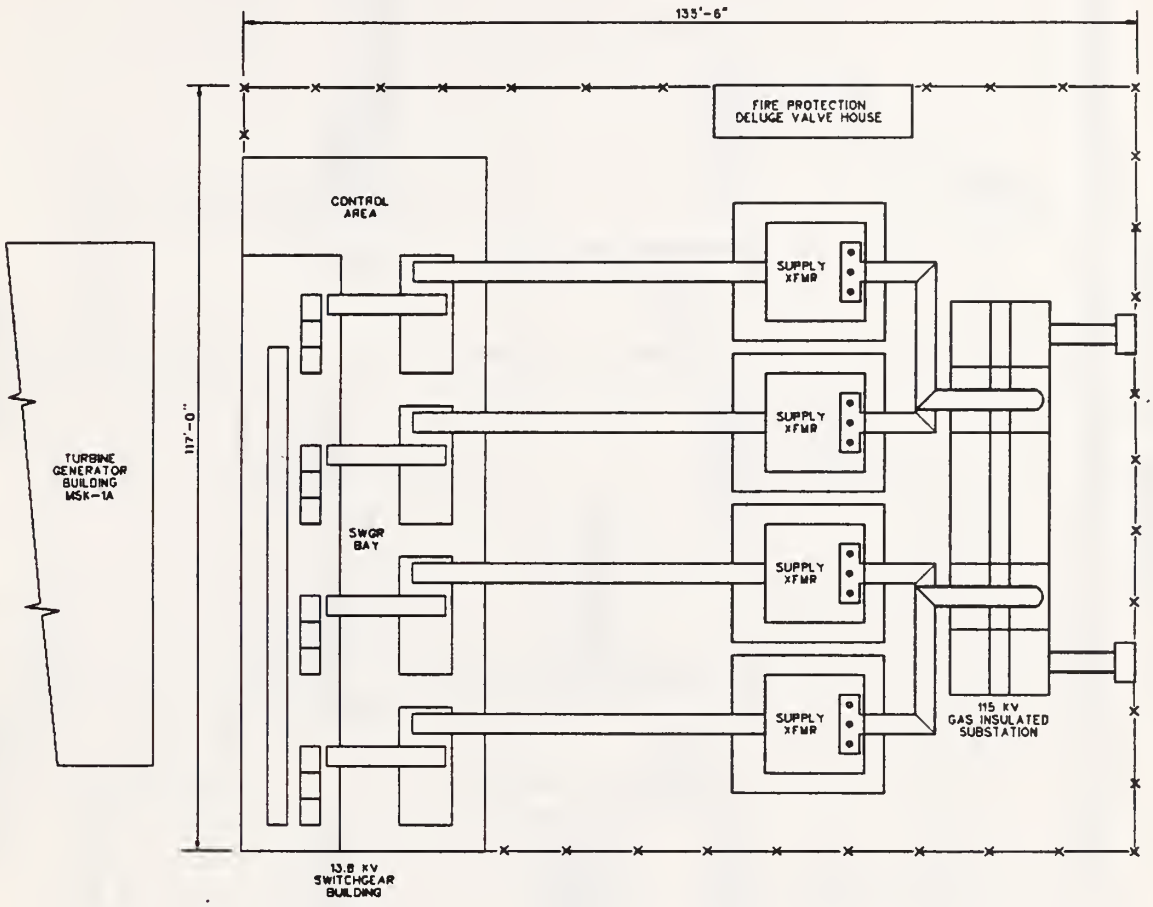
FIGURE 11.1.3-25
PROPOSED ROUTING OF ELECTRICAL SERVICE

Placing the feeders in service also requires the installation of a 115 kv to 13.8 kv substation on Deer Island. It is envisioned that MWRA and BECo will jointly own the 13.8 kv switchyard, and MWRA will own the distribution system. In order to utilize the 115 kv power, construction of the switchyard must be complete by the scheduled feeder inservice date of January 1, 1992. This will require a joint BECo-MWRA effort. The switchyard will be arranged as shown on the electrical one line drawing, Figure 11.1.3-26.

Electrical Power Distribution. Electrical Power will be distributed from the switchgear building to unit substations located throughout the facilities. Power will be distributed at 13.8 kv to the unit substations.

Space has been allocated at the four 13.8 kv buses for dual feeds to twenty (20) unit substations. At each of the four 13.8 kv buses, there will be approximately 10 feeders (subject to the balancing of loads during final design). To ensure the continuity of electrical power, the distribution of power to the unit substations and from the unit substations to the motor control centers (MCCs) is a redundant system. The electrical power supply one-line diagram for the 13.8kv feeders is shown on Figure 11.1.3-27. For example, unit substation No. 1 will have a 13.8 kv feeder from the 13.8 kv bus No. 1 to a 13.8 kv/480 V transformer and will also have a 13.8 kv feeder from the 13.8 kv bus No. 3 to a 13.8kV/480 V transformer. The schematic of unit substation No. 1, which is typical for all other 480 V unit substations except as noted below, is shown in Figure 11.1.3-28. At the unit substation each of the feeders from the power supply feeds a 480 V bus. From each of these 480 V buses a feeder then connects to the MCC. A failure of any switchgear, transformer, or line feeder will not result in downtime of the equipment being powered; as the power will be switched to the available redundant line.

The location of the unit substations at Deer Island are indicated in Figure 11.1.3-29. Of the twenty unit substations, fifteen are for the liquid treatment facilities, one is for the pier facilities, two have been reserved for the residual needs, and two have been left as spares. The unit substations are tabulated in Table 11.1.3-5. Generally, substations have been assigned to supply half of the process power needs of a unit process. For example, the unit substation No. 1 will supply power to the eastern batteries of the primary treatment process and unit substation. Unit substation No. 2 will supply power to the western batteries of the primary treatment process. Most unit substations will step the power down from 13.8 kv to 480 V. Unit substations Nos. 3, 12, and 13 must meet power loads associated with either influent pumping or oxygen production and will, therefore, step power down from 13.8 kv to 4160 V. The power distribution from these substations, however, is similar to the others. Substation No. 14 will feed power to the existing Main Pumping Station. The existing distribution of power within the main pump station is different from the proposed distribution for all the other substations. This is a result of on-going work associated with the production and distribution of on-site power directly to the pump drivers at that location.




SWITCHYARD

0 8 16 24
SCALE-FEET

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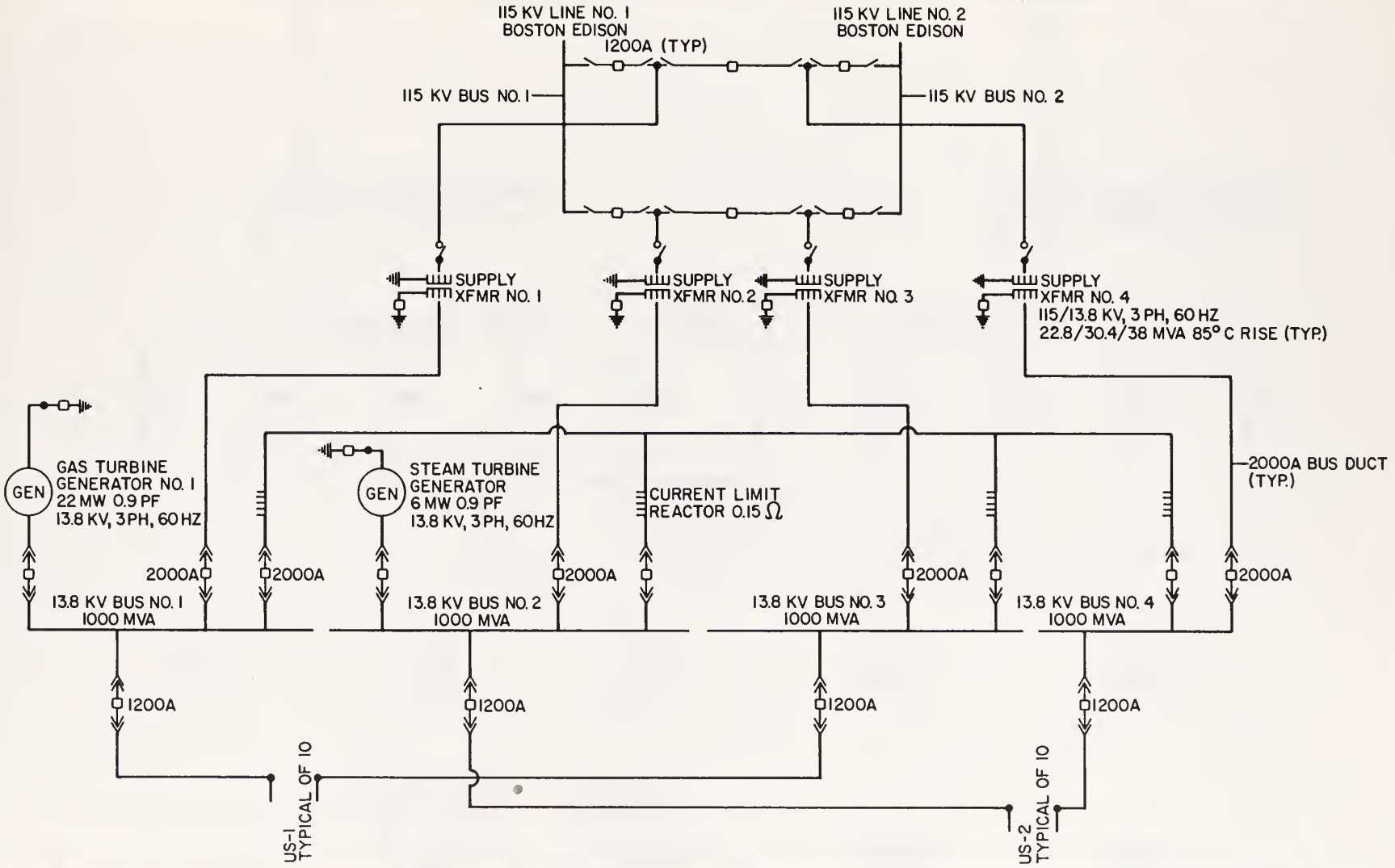
FIGURE 11.1.3-26
ELECTRICAL SWITCHYARD PLAN




| | |
|---|---|
| **MASSACHUSETTS WATER RESOURCES AUTHORITY** | **FIGURE 11.1.3-27 ELECTRICAL ONE LINE DIAGRAM POWER SUPPLY** |

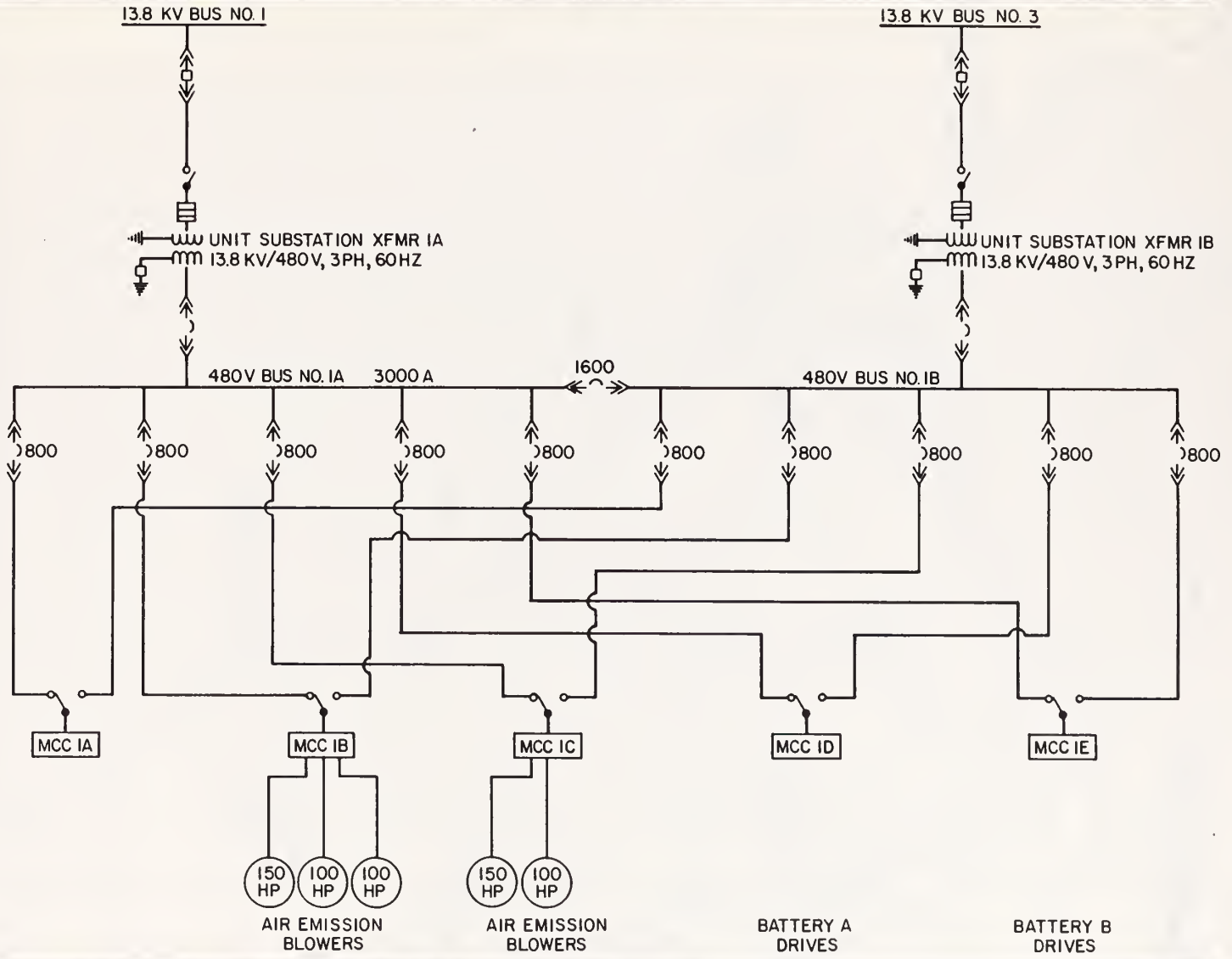



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**FIGURE 11.1.3-28**
**ELECTRICAL ONE LINE DIAGRAM**
**TYPICAL 480V UNIT SUBSTATION**

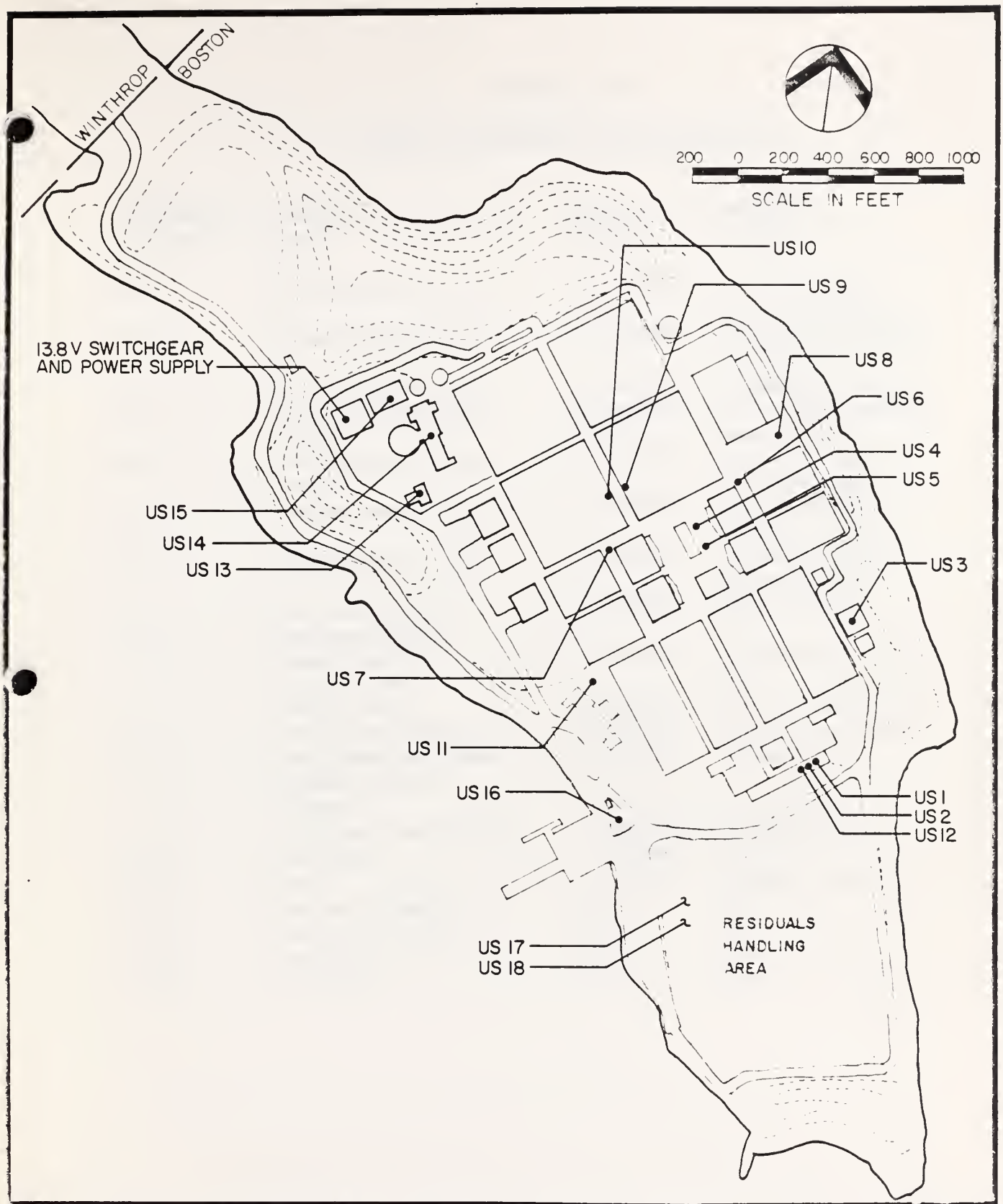


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**FIGURE 11.1.3-29**
**LOCATION OF**
**ELECTRICAL UNIT SUBSTATIONS**

## TABLE 11.1.3-5

## POWER DISTRIBUTION UNIT SUBSTATIONS

| UNIT SUBSTATION NUMBER | SERVICE AREA | XFMR SIZE | PRINCIPAL LOADS |
|---|---|---|---|
| US-1 | Primary Batteries A and B | 13.8kV/480V | Air emission fans, chain and flight drivers |
| US-2 | Primary Battries C and D | 13.8kV/480V | Air emission fans, chain and flight drives |
| US-3 | Oxygen Production Plant | 13.8kV/4160V | Compressors, Cold Boxes |
| US-4 | RAS pump stattion battery A and B | 13.8kV/480V | RAS and WAS pumps air emissions fans |
| US-5 | RAS pump station battery C and D | 13.8kV/480V | RAS and WAS pumps air emission fans |
| US-6 | Aeration Batteries A and B | 13.8kV/480V | Mechanical aerators, mechanical mixers |
| US-7 | Aeration batteries C and D | 13.8kV/480V | Mechanical aerators, mechanical mixers |
| US-8 | Plant water/Disinfection | 13.8kV/480V | Plant water pumps |
| US-9 | Secondary Clarifiers Battery A and B | 13.8kV/480V | Chain and flight drives |
| US-10 | Secondary Clarifiers Battery C and D | 13.8kV/480V | Chain and flight drives |
| US-11 | Administration/Maintenance | 13.8kV/480V | Lighting, machine shops |
| US-12 | South System Pump Station | 13.8kV/480V | Influent Pumps |
| US-13 | Winthrop Terminal Facilities | 13.8kV/4160V | Influent Pumps |
| US-14 | North Main Pumping Station | 13.8kV/4160V | Influent Pumps |
| US-15 | Power Plant | 13.8kV/480V | Starters |
| US-16 | Piers | 13.8kV/480V | Unloading Pumps |
| US-17 | Reserved for Residuals | N/A | N/A |
| US-18 | Reserved for Residuals | N/A | N/A |
| US-19 | Spare Feeder | N/A | N/A |
| US-20 | Spare Feeder | N/A | N/A |

For the substations located in the primary facilities, the feeder cables to the substation location will be run in a buried ductwork system. For the secondary treatment facilities, the feeder cables to the substation location can be run within the pipe galleries in trayed systems.

Combustion Turbine Combined Cycle. The addition of a combined cycle power plant at Deer Island is cost effective for peak shaving. It will also provide protection against catastrophic failure of the offsite power sources.

Based on a present worth analysis, a 25,700 kw combined cycle plant is recommended. This additional capacity, combined with existing and soon to be installed Fast Track capacity, will result in an installed onsite capacity of 41,200 kw. This assumes that, although retired, the Enterprise engines will still be on-site and available for use if necessary. The 41,200 kw on-site capacity will be sufficient to satisfy all the essential average requirements, and 92 percent of the essential peak energy requirements, for the life of the project.

The schedule for installation of the combined cycle plant will depend on several factors. The schedule of power needs, including required construction power, indicates a shortfall of 5050 kw of peak secure capacity in 1991 if 15,000 kw of immediate power is available from the Winthrop grid. However, if it is assumed that secure capacity construction power is required only for personnel safety, the shortfall diminishes. In addition, if as much as 20 MW of immediate power is available from MECo instead of the currently projected immediate power availability of 15 Mw, the shortfall will be non-existent even if construction power is deemed essential. Lastly, if both 115 kv feeders can be constructed by BECo in parallel, ample secure capacity would be available.

If, for some unforseen reason, an energy shortfall still exists, the early installation of the combustion turbine portion of the proposed onsite capacity addition is still an implementable fallback position. In any case, based on the results of the power study included in Appendix H, the complete onsite capacity addition should be available by 1995 in order to be most cost effective. The power study indicates that the unit cost of self-generated energy is less than the unit cost of purchased energy during peak hours. Thus, the return on the investment of self-generation capacity is maximized by bringing it on-line in 1995, when increased power demands associated with the new treatment facility operation justify peak-shaving operation. Onsite generation capacity would consist of a combustion turbine, a heat recovery steam generator, and a single extraction condensing steam turbine. It is envisioned that all process and building heat requirements will be satisfied by the extraction steam. For this reason, it is recommended that the capability for supplemental firing of the heat recovery steam generator be provided.

The combined cycle power plant will require up to 50 gpm of demineralized water. This water will be used to make up losses due to water injection to the combustion turbine for $NO_x$ suppression and blowdown losses to the heat recovery steam generator. The source of water for this use should be potable water initially. After secondary effluent is available in 1999, filtration and demineralization treatment of the 50 gpm makeup flow may be feasible, using

secondary effluent as the source.

The condenser cooling water requirement will be approximately 2000 gpm (approximately 3 MGD). It is proposed to use primary plant effluent for this initially, with a switchover to secondary treatment plant effluent when it is available. The cooling water temperature rise across the condenser will be limited to $15^0$ F. Since it is proposed to return this to the plant outfall, the resultant small temperature rise of the combined effluent will not be detectable.

The power plant will be totally enclosed in a building, approximately 77 ft by 147 by 49 ft, having a stack 122 ft high. Plot dimensions of 80 ft by 150 ft, and a building height of 50 ft have been used for planning purposes. The arrangement of the equipment is as shown in Figures 11.1.3-30 and 11.1.3-31.

Heating Demand. The heating demand at the MWRA Deer Island wastewater treatment plant will increase as new facilities are constructed to provide improved wastewater treatment for increased volumes of wastewater. The heating load varies annually in accordance with the number of degree days per month. The average heating load was adjusted in stepped increments to accommodate heating loads associated with increases in building and gallery volumes and implementation of secondary treatment.

Total seasonal heating loads were determined by using published data that give season steam demand per degree day per 1,000 $ft^3$ to be heated for the various types of buildings. This reflects hours per day of occupancy and required comfort levels. A value of 1,000 Btu/lb of useful heat is assigned to a pound of steam. For the buildings, a value of 0.962 lb steam/degree day/1000 $ft^3$ was used. For the tunnel galleries, a value of 0.202 lb steam/degree day/1,000 $ft^3$ was used. This preliminary heating load estimate was based on an ultimate building volume of 8,000,000 $ft^3$ and tunnel gallery volume of 6,000,000 $ft^3$.

The number of degree days per month and the expected monthly heat loads are shown in Table 11.1.3-6.

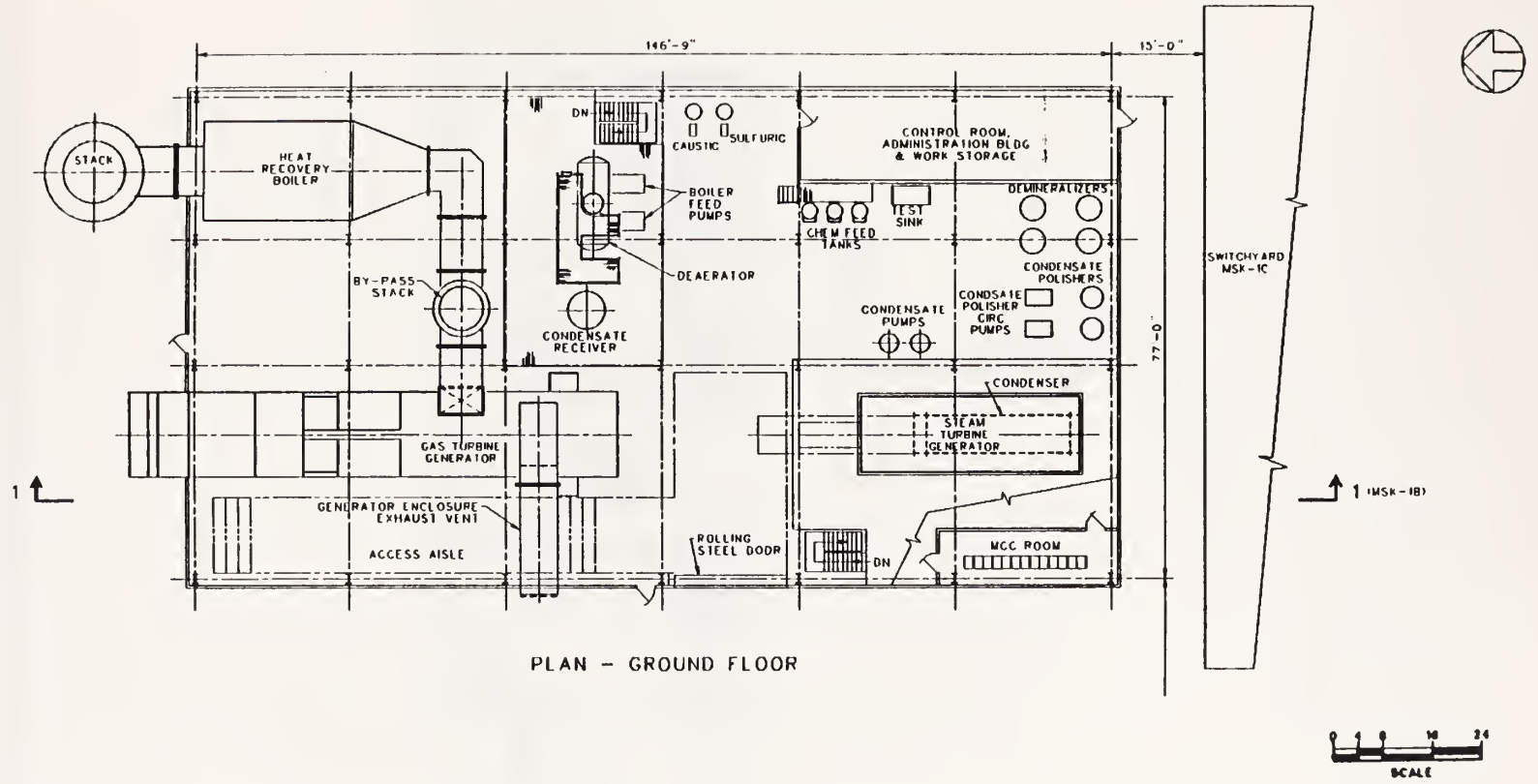
The source of heat will be the extraction steam from the combined cycle power plant. This need can be satisfied by either running the combined cycle plant to maximize electrical generation, or by utilizing the supplemental firing feature to generate steam for heating to minimize electrical generation when cost effective. It is recommended that a closed loop system be provided for steam distribution, with heating drains being returned to the power plant for reuse. A preliminary steam distribution and condensate return distribution system is shown in Figure 11.1.3-32.

Should anaerobic digesters be included as part of the treatment facility, additional heating will be required. This heating load was calculated for the level of treatment to be in place in 1995, and in 1999. The average monthly heating loads are listed in Table 11.1.3-7.

## TABLE 11.1.3-6

## HEAT LOAD PER MONTH, BUILDING AND TUNNELS

| Month | Degree Days | Heat Load/months (Btu x $10^6$) |
|---|---|---|
| January | 1088 | 16,600 |
| February | 972 | 14,900 |
| March | 846 | 13,000 |
| April | 513 | 7,800 |
| May | 208 | 3,200 |
| June | 36 | 600 |
| July | 0 | 0 |
| August | 9 | 140 |
| September | 60 | 900 |
| October | 316 | 4,800 |
| November | 603 | 9,200 |
| December | 983 | 15,000 |
| | 5634 | 86,140 |




PLAN - GROUND FLOOR

11-78

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**FIGURE 11.1.3-30**
**POWER HOUSE ARRANGEMENT**

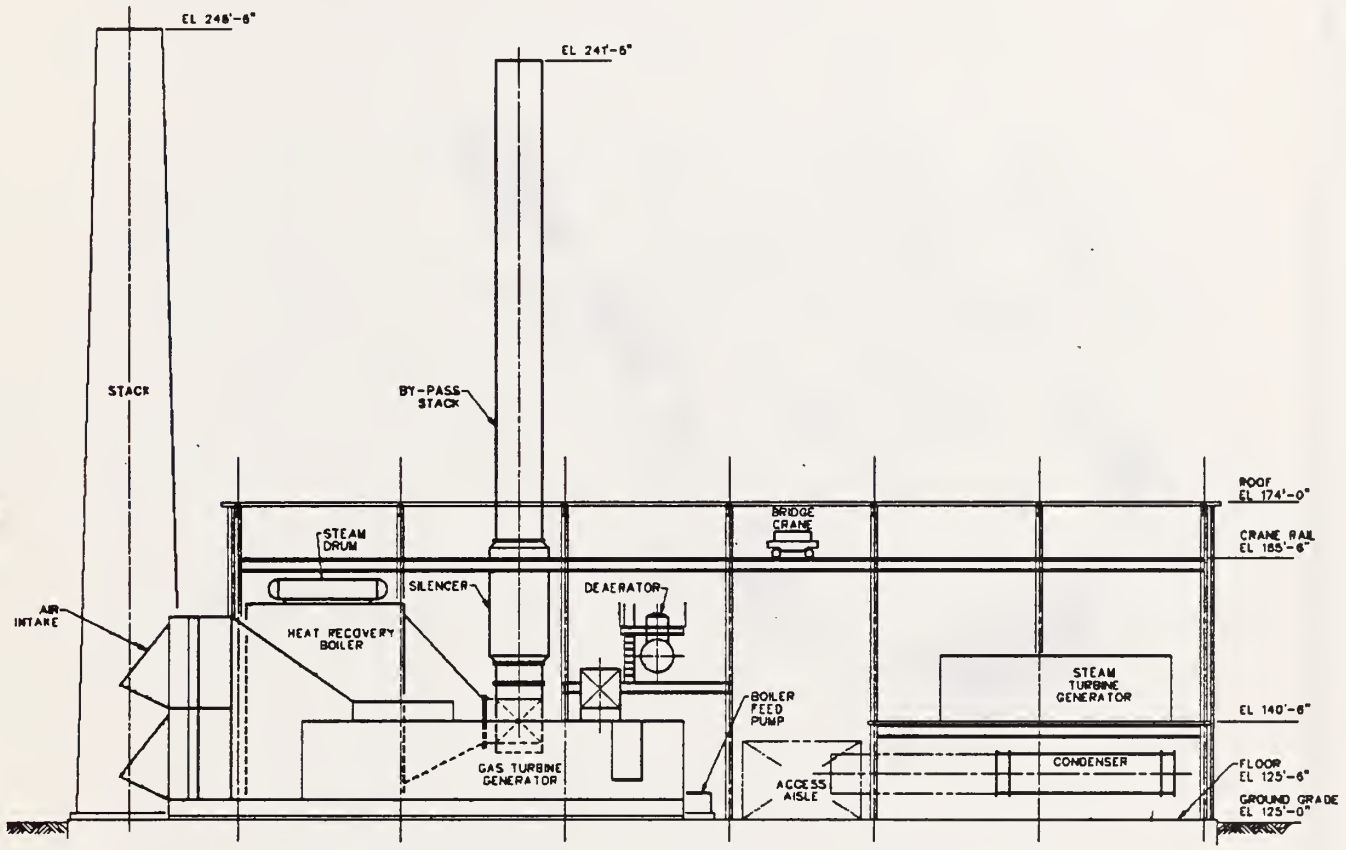


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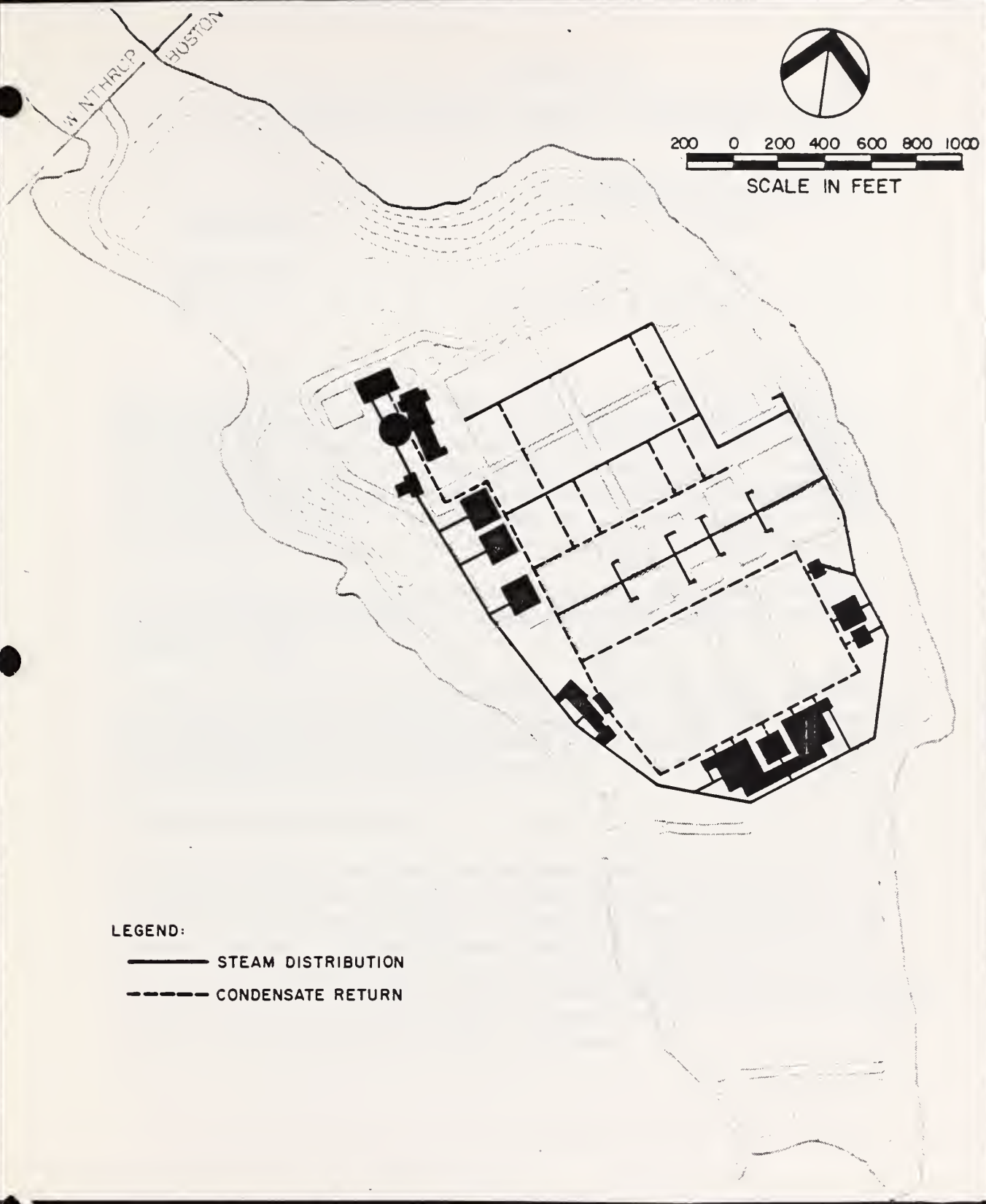
FIGURE 11.1.3-31
POWER HOUSE ELEVATION




| | |
|---|---|
| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.1.3-32 STEAM DISTRIBUTION AND CONDENSATE RETURN |

TABLE 11.1.3-7

PROJECTED AVERAGE MONTHLY DIGESTER HEAT LOADS

| Milestone date | Average monthly heat demand Btu x $10^6$ |
|---|---|
| 1995 to 1998 | 11,130 |
| 1999 to 2020 | 21,000 |

Fuel. The fuel requirements to satisfy required electrical generation and heating demand average 400,000 gal per month of No. 2 oil. It is currently proposed to deliver the fuel by barge. Barges having a capacity of 400,000 gallons are 165 ft long, 34 ft wide, and draw 10 ft when fully loaded. It is proposed that sufficient on-dock unloading capability be provided in order to reduce the dockside time to one day. This will entail providing an unloading capacity of 10,000 gph. The requirement will be four 2,500 gph per hr pumps, pumping through two, eight-inch diameter lines routed in a pipe chase from the dock to the oil storage tanks.

The fuel storage requirement is for a 30-day reserve. This will require two 400,000 gal oil storage tanks in a diked area adjacent to the proposed power plant. These tanks will be 60 ft diameter by 20 ft high.

As an alternative to fuel oil, the use of natural gas was considered. Discussions with Boston Gas resulted in a cost estimate of $5,000,000 to bring gas service to Deer Island. However, no fuel cost information could be made available since Boston Gas had not yet made arrangement to secure sufficient gas to serve the Deer Island need.

Potable Water and Plant Water System

Potable water needs for the new Deer Island wastewater treatment facilities were estimated contrasted with existing water availability, and alternative approaches to support Deer Island's water supply needs were evaluated. The details of the water supply investigations are presented in Appendix I. The following section summarizes the results of this study, and the recommended plan for providing potable water to Deer Island. [It should be noted that the elevations of the MWRA water system are measured from the Boston City Base Datum (BCBD), and therefore, BCBD has been used in this section. The BCBD is 99.47 feet below the MDC sewer datum, which is used throughout other sections of this report.]

Potable water is currently supplied to Deer Island from the Winthrop water distribution system. Winthrop's water is received from the MWRA's Northern High Distribution System (NHDS) via a connection designated "Meter 41" at the Winthrop/Revere boundary. Meter 41 consists of a 20 inch main, a 16 inch main, pressure reducing valves, and a meter. The hydraulic grade line upstream of Meter 41 is approximately 240 feet above the Boston City Base Datum (BCBD) under average day flowrates, and drops to approximately 200 feet BCBD under peak flow rates.

The town's present average day demand is approximately 2 mgd. The town is nearly fully developed and future water needs are expected to increase slowly by a maximum total of 10 percent. The town's peak daily demand is estimated to be approximately 3.5 mgd. Required fire flow for Winthrop is 3500 gpm.

The Winthrop distribution system was designed to operate with the MWRA pressure regulators at Meter 41 set at elevation 203, BCBD (75 psi). However, in order to reduce the rate of leakage from some of the town's older pipes, the town limits pressure at Meter 41 to between 60 and 65 psi. Winthrop is steadily replacing those sections of pipe which leak excessively, and intends to increase the pressure setting at Meter 41 to the design point when the system leakage has been sufficiently reduced.

Distribution storage in Winthrop is provided by an uncovered standpipe on Cottage Hill near Point Shirley. The standpipe is 100 feet high and 40 feet in diameter and has a capacity of 0.94 million gallons when filled to the overflow pipe, at elevation 205.65 BCBD. However, because of the pressure reduction at Meter 41 the standpipe cannot be filled, and the available storage is inadequate to meet the town's needs during times of peak flowrates on days of maximum daily demand.

Potable water is presently used at the wastewater treatment facility for toilets, sinks, drinking fountains, sludge heaters, engine cooling, equipment flushing and washdown, and seal water. Current average and maximum consumption rates are 0.1 mgd and 0.2 mgd, respectively. Water use will increase when the plant is upgraded to a minimum daily consumption of 1.0 mgd and a maximum daily consumption of 2.0 mgd.

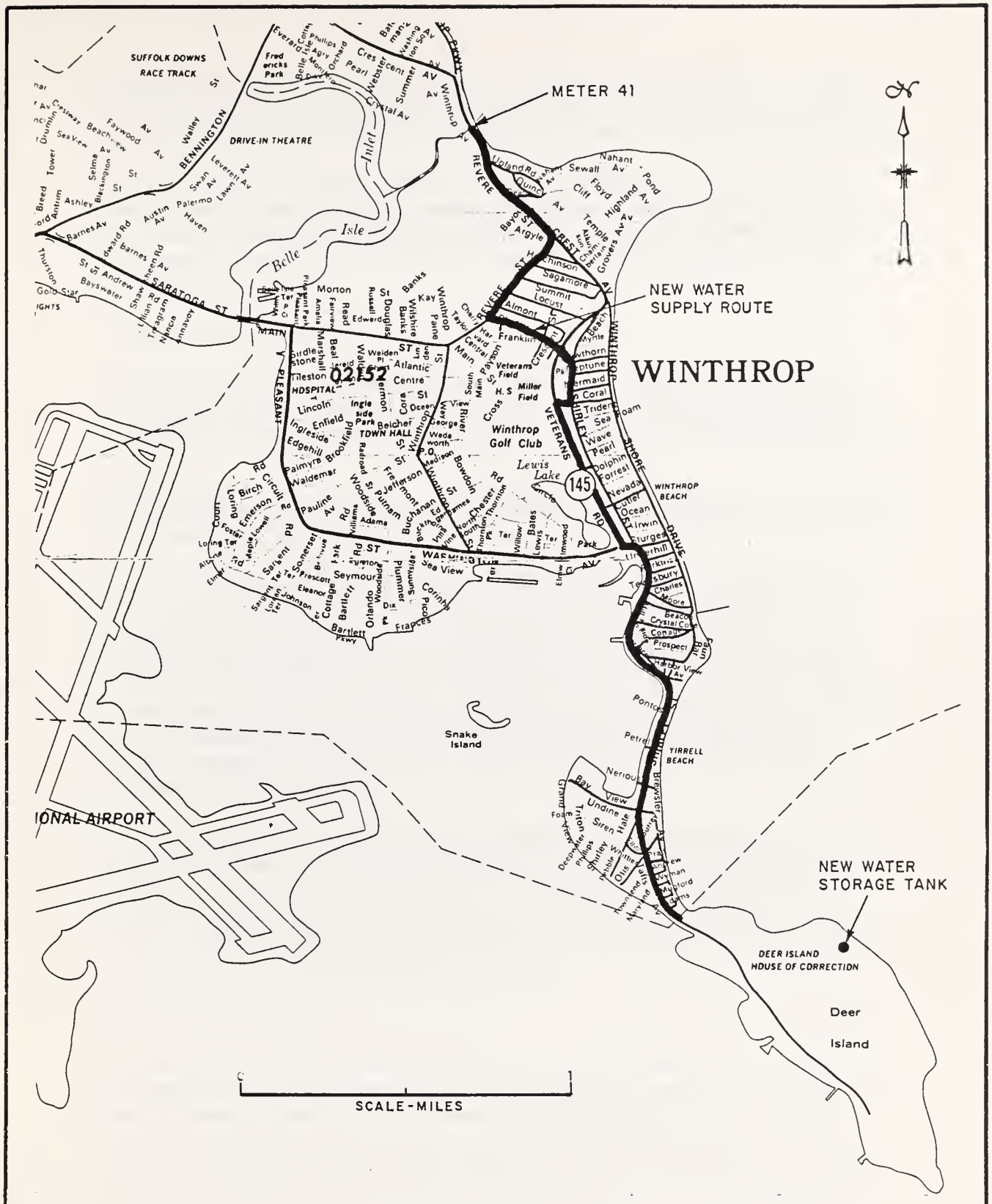
In order to minimize the consumption of potable water, the recommended Deer Island facilities are designed to reuse primary and/or secondary effluent for those purposes which do not require potable quality water. Non-potable water is designated "plant water," and will be used as necessary for engine cooling, process equipment flushing and equipment washdown. Plant water will be provided by a 45 mgd (31,250 gpm) plant water pump station discharging directly to the plant water distribution system. The plant water pump station will be located adjacent to the new disinfection facilities and will consist of five, 15 mgd capacity pumps in parallel, and normally will operate with three or fewer pumps on-line, one pump on standby, and one pump available for maintenance.

Present and projected potable water consumptions for both the Town of Winthrop and the treatment facilities are summarized below:

| | 1987 | 2000 |
|---|---|---|
| Average consumption (MGD) | | |
| Winthrop | 2.0 | 2.2 |
| Deer Island | 0.1 | 1.0 |
| TOTAL | 2.1 | 3.2 |
| Maximum consumption (MGD) | | |
| Winthrop | 3.5 | 3.9 |
| Deer Island | .2 | 2.0 |
| TOTAL | 3.7 | 5.9 |
| Required fire flow (gpm) | | |
| Winthrop | 3,500 | 3,500 |
| Deer Island | n/a | 3,000 |

Potable water needs required by the new Deer Island facilities cannot be supplied through Winthrop's existing distribution system due to the limitations of that system. Along the route from Meter 41 to Deer Island, Winthrop's water transmission mains consist mostly of 16, 12, and 10 inch diameter piping. Hydraulic modelling has shown that this system is not capable of providing the additional water at the flowrates and volumes required for the Deer Island facilities. Current plans to upgrade segments of the Winthrop system will improve the existing condition but will not support water requirements for the new wastewater treatment facility. However, there is an adequate supply of water available at Meter 41. The water supply study presented in Appendix I has concluded that Deer Island potable water needs are best met by constructing a dedicated main through Winthrop to Deer Island. The proposed route of the new line is shown on Figure 11.1.3-33. A 20-in-diameter main will be used for the new water supply service. Assuming a minimum residual pressure at Deer Island of 30 psi, the new service will be capable of delivering a fire flow of 3,000 gpm, plus the maximum day demand. The new water supply could also provide for improving distribution capacity in Winthrop's system by the addition of one or two cross-connections and meters between the new 20 inch main and Winthrop's distribution system.

The recommended plan provides for on-site storage of potable water at Deer Island in order to dampen the effects of diurnal flowrate variations, to provide adequate pressure for firefighting, and to provide a source of water in the event of a break in the dedicated main. The proposed on-site storage volume is equal to the estimated fire flow volume of 540,000




MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 11.1.3-33**
**PROPOSED ROUTING OF POTABLE WATER SERVICE**

gallons (3,000 gpm for 3 hours) plus 50 percent of the maximum day demand, or 1.0 MGD. The total storage volume is therefore 1.54 million gallons. In order to meet the minimum pressure criterion of 30 psi, the tank must be above approximate elevation 125 feet BCBD (225 MDCSD).

It is recommended that distribution systems for both potable (and fire protection) and plant water will be loop distribution piping systems, which would be routed around the perimeter of the treatment facility complex, and be provided with branch service to the respective buildings and equipment. Routing will be similar to that shown for the steam distribution system, on Figure 11.1.3-32.

Basin Dewatering System

A gravity dewatering system capable of dewatering individual treatment process basins within the period of one shift, or approximately 6 to 8 hours, is proposed. The dewatering system will dewater the basins to either the South System Pumping Station or to Winthrop Terminal Facility.

The grit chambers will drain through an 18-in-diameter pipeline which will flow to the wet well of the South System Pumping Station.

The primary clarifiers and the secondary clarifier basins will be drained as stacked sets, from the invert of the sludge hoppers. The primary clarifiers will be drained through the same 18-in-diameter pipeline that serves the grit chambers, which is connected to the wet well of the South System Pumping Station. The secondary clarifiers will drain to the wet well of the Winthrop Terminal Facility through an 18-in pipeline. The anaerobic selector basins and the aeration basins will drain by means of mud valves located in the floor of each stage. The mud valves drain through a drainage pipeline located in the passageway gallery between the anaerobic selector basins and the aeration basins. This drain is connected to the pipeline that drains the primary clarifiers.

The disinfection basins drain through an 18-in-diameter piping interconnection to either the primary clarifier drain or the secondary clarifier drain. Until the secondary treatment facilities are constructed, the disinfection basins will drain via a siphon pipeline through the primary clarifier drain to the South System Pumping Station. After construction of the secondary clarifiers, the disinfection drainage system can be made more flexible by means of an interconnection to the secondary clarifier drain pipeline.

Storm Drainage System

The plant site storm drainage system will consist of a number of independent drainage systems, each serving an area of about four acres. (The subdrainage area will be sized according to the final site grading plan and plant facility layout.) Stormwater collected from roof drains, down spouts, and roadway and yard catch basins, will be transmitted through a series of manholes and pipelines, designed with the capacity to handle a 1-hr, 100-year storm event. The systems will discharge to ocean outfalls located on the perimeter of Deer Island. These

outfalls, discharging at the mean high water level, will be designed with concrete headwalls, and be protected against wave action with riprap. Where feasible, the drainage systems will incorporate the existing Deer Island drainage system, and the proposed drainage system for the pier facilities. Site drainage for the residuals handling area will be incorporated in the Residuals Management Facilities Plan.

Flow-regulating valves located in the South System Pumping Station and the Winthrop Terminal Facility are required to control the dewatering system.

Fire Protection

Fire protection at Deer Island is currently provided by the City of Boston and Town of Winthrop. Because of the site's geographical isolation, and frequency of exhaust stack fires at the pumping station and brush fires on the island, the responsibility on these reporting municipalities has been burdensome.

In order to reduce the burden of fire protection on nearby communities, it is recommended that the MWRA provide its own fire protection organization and equipment. It is recommended that the MWRA follow the National Fire Protection Association (NFPA) recommendations for the organization, training, and equipping of private fire brigades (NFPA600).

Organization. The MWRA fire brigade will be made up of Deer Island treatment plant operator volunteers. The Brigade organization will consist of a full-time fire chief under the Safety Unit located in the Administrative Section; and five assistant chiefs, one for each working shift. The fire chief will be responsible for all aspects of the brigade activities, such as fire prevention, fire safety programs, and training under the direction of the training and safety officers, and equipment procurement and maintenance, issuance of hot work permits (e.g. welding), maintenance and review of necessary reports and records, investigation of fires, and coordination with local public fire authorities. Enough assistants will be appointed so that there is always an assistant chief on duty every day and around the clock. The duties of the assistant chiefs will be assigned to secondary foremen located in the operations and maintenance center of the treatment facility complex.

The MWRA fire brigade will be capable of dealing with small fires. Control of major fires will require the support of public fire departments from surrounding communities. Members of the fire brigade will include representatives from all departments of the wastewater treatment plant operating organization. The equipment and number of persons that must be put into service during a fire emergency will be determined by the type of fire emergency which must be controlled.

Under the direction of the Training Officer, training will be carried out in accordance with the recommendations of the NFPA and will consist of a combination of classroom instruction and drills.

Equipment. Based on a preliminary analysis of building type and area requirements at the wastewater treatment plant, the list of equipment with which the fire brigade will be provided is as follows:

(a) Small, multipurpose truck for equipment transport
(b) Hose and hose accessories
(c) Ladders
(d) Portable fire extinguishers
(e) Rescure and first aide equipment
(f) Personnel protective equipment
(g) Sepcial purpose equipment (for special hazards, communications, etc.)

The equipment will be located in the vehicle maintenance facility (building number 46) shown in the site plan, Figure 11.1.3-1 at the end of this volume.

Water Supply and Distribution. The recommended potable water storage tank is sized to provide 3,000 gpm of firefighting water for 3 hours. Distribution of fire fighting water throughout the site will be by a distribution loop. The loop will be designed to conform to NFPA recommendations, and the requirements of the insurance underwriter. This loop will supply water to valved branches serving fire hydrants located throughout the treatment facility complex. Hydrants will be spaced to permit exterior fire fighting with hose lines not exceeding 500 feet in length.

Valved branches from the distribution loop will be located at buildings, tunnels, and galleries where interior fire protection (sprinklers and/or standpipe and hose stations) is required. Valves at the branches would be post-indicating type gate valves which provide for positive open/close status indication.

For interior spaces where fixed water fire protection equipment (e.g. sprinklers) are required, either automatic preaction or deluge systems and/or hose stations will be provided. Permanent hose stations within the builldings will be located at a maximum of 100 foot intervals and will include hoses equipped with adjustable spray nozzles of sufficient length to provide overlapping coverage.

Within the plant where special hazards exist or where water can not be used, a Hernate fire protection systems such as foam, carbon dioxide, and/or halon will be provided.

Fire Detection. Smoke, flame, and temperature detection will be provided for monitoring discrete points and large zones throughout the plant. The detection system will interface with the site security system (fire control panel) to inform Security Personnel of fire-related events. The components used in the detection system will be Underwriters Laboratory (UL) listed and in accordance with the applicable subsections of NFPA. Individual detectors will be suited to the probable type of fire, and may include ionization type detectors sensitive to products of combustion for smoldering type fires, rate compensated thermal detectors for

combustible liquids, and/or photoelectric smoke detectors for area monitoring.

Telecommunications

Headworks/Pumping Station Data Communications. The existing system for transmission of data between the remote headworks and Deer Island consists of redundant data paths, one by microwave and one by leased telephone lines. The failure of either path does not interfere with data transmission via the alternate path. It is proposed that this two-way data communication concept also be used for the new pumping facility provided at Deer Island.

In the existing system, the primary data path is the microwave system, which consists of two microwave links. One link services the Chelsea Creek Headworks and the other services both Columbus Park and Ward Street Headworks. Each of these microwave links transmits both voice and data between the Headworks and Deer Island. Current data transmition consists only of flow and level information, however, considerable spare capacity exists in the data links which could be used for increased future data transmission if required.

Leased telephone lines provide backup to the microwave data links. These leased lines provide services identical to those provided by the microwave links.

The existing microwave system is adequate for future communications needs between the existing headworks and the Deer Island pump station. With the construction of a new headworks facility on Nut Island, discharging to the new Deer Island South System Pump Station through the new Interisland Tunnel, telecommunications requirements between the Nut Island Headworks and Deer Island will be similar to those between the existing remote headworks facilities and Deer Island. A system is therefore proposed, similar to the existing systems, consisting of a microwave transmitter backed up hard wire telephone communication. The recommended Deer Island and Nut Island site plans provide a direct line of sight between the roofs of the Nut Island headworks facility and the South System Pumping Station, which will be used for microwave transmission.

Internal Data and Voice Communications. The microwave system described above will be integrated into the data collection, storage, and processing system provided at the treatment facility central control center, with the provision of new multiplexers replacing the existing multiplexers which are becoming unreliable and will convert the existing microwave/telephone link data to the format required by the new computer system.

An internal paging and intercom system will be provided.

Deer Island Voice Communications. Telephone communications with Deer Island are currently provided by a 9 pair trunk line owned by New England Telephone (NET). In anticipation of the need to upgrade the wastewater treatment plant telephone system when the plant is upgraded, NET is currently in the process of increasing the trunk line to 46 pairs of wires. New England Telephone has advised the MWRA that the improved trunk line will be adequate for any telephone system the MWRA chooses to install. The installation is currently complete to the main gate of

the wastewater treatment facility.

Security Planning

Security considerations for Deer Island focus on three areas: perimeter, area, and building security. Recommended provisions for security are described below.

Perimeter Security. There are two access points to Deer Island: an overland access through the town of Winthrop and an overwater ferry access through the pier facilities. The northern, overland access road onto Deer Island traverses the buffer zone between Point Shirley and the treatment facilities. Public access to this buffer zone, as well as to an extension of the buffer zone which skirts the eastern ring of landforms connecting to the southwesternmost tip of Deer Island, will normally be permitted during the daytime. Access to these buffer areas will be controlled by a gate, located at the property line which could be closed at night and when activities occuring at the treatment facility require closure.

A gatehouse will be located on the overland access road beyond the buffer zone at the entrance to the treatment facility. It is recommended that the former Prison Superintendent's House be relocated, renovated, and reused for this purpose. Security personnel based at the gatehouse will control all overland vehicle and pedestrian access to the treatment facilities area.

The treatment facility area will be secured with a fence. The security fencing will completely surround the treatment facility complex and will be located generally at the inside toe of the landforms. On the western side of the island, a single access control point will be provided for over water acces through the pier facilities.

Area Security. Certain portions of the facility, both inside and outside the perimeter fence will be observed through the use of a closed circuit television system. Examples of areas requiring surveillance are: the pier facility, the buffer zone gate area, and the main gate. A typical outdoor camera installation would consist of the following: low light level camera, auto iris zoom lens, protective housing, pan and tilt drive, and a mount.

Building Security. It is recommended that, depending on identified risks involved, certain buildings, and spaces within these buildings be equipped with intrusion detection devices and/or television monitors. Examples include: the cryogenic facility, the power facility, administrative building, pumping stations, warehouse facility, and any other area of concern to facility management where undetected intrusion would cause a property loss or a potential liability. Typical intrusion sensors would be magnetic door position switches and motion detection sensors. Application of these devices is dependent on risk, occupancy, and environmental conditions. Authorized access to these areas would be accomplished through the use of specially encoded badges used in conjunction with an electronically controlled access system. This system would provide for the reporting and recording of both authorized and unauthorized access activity.

Security Force. It is recommended that the facility be staffed with a full-time security force to control access and egress. This will limit the potential liability due to an innocent unauthorized entry into a dangerous area, and will control internal theft. The security force will be based at the gatehouse. Space needs at the gatehouse include a transportation and security operations center, break and change rooms, restrooms, and equipment storage.

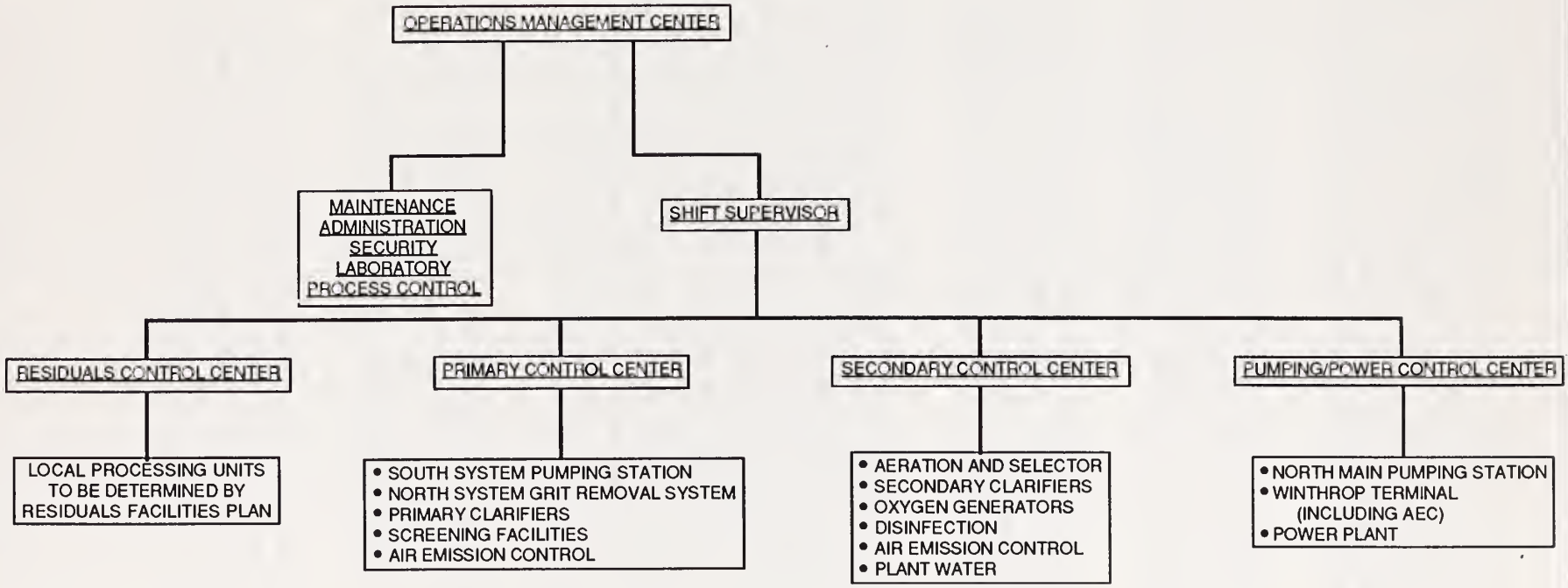
The transportation and security operations center would house the alarm reporting system, access control central processor and display, closed circuit television system controls and monitors, a video tape recorder, radio communications system, watchman's supervision system, and selected lighting control. The security operations center would also be the location of facility key issuance and control. The security force should be equipped with all necessary uniforms and items of equipment such as flashlights, portable radios, and an appropriate vehicle(s). Policies and procedures will be developed to assure optimal usage of personnel. This would include physical and procedural training as well as areas of responsibility. This training should be conducted on an ongoing basis. Typical duties of a security force would include: vehicle and personnel access control, vehicle inspection, key issuance and control, badge issuance and accountability, disaster preparedness, loss control, surveillance, and safety policy enforcement.

During the construction phase of the facility, the security force could be tasked with controlling contractor personnel and equipment access and egress. Typically the amount of manpower required and duties assigned during the construction of a facility will be greater than those required after completion. Security staffing for construction and facility operation is further described in sections 11.2 and 11.6 respectively.

Instrumentation/Control

Plant control will be provided via a Distributed Digital Control and Central Information System. This system will consist of a central computer in the Operations Management Center, located in the Administrative Building, Distributed Processing Units (DPUs) in the plant's four main process control centers, and Local Processing Units (LPUs) at the various local control panels throughout the plant. Use of the distributed digital control system will provide a de-centralized plant operation. Overall plant operating decisions will be made at the Operations Management Level with implementation occurring at the four main control centers. The four main control centers comprise the Primary Control Center, the Secondary Control Center, the Pumping/Power Control Center, and the Residuals Control Center. Input from security, maintenance, and the plant laboratory will go directly to the central processing unit in the Operations Management Center for distribution to the other control centers. A schematic of the proposed control system is shown in Figure 11.1.3-34. Major areas of control for each of the main control centers are shown on the schematic. Control areas related to residuals handling will be determined by the Residuals Management Facilities Plan.

The Central Control Room will be located in the Operations Management Center in the Administrative Building. This area will house redundant Central Processing Units (CPUs) for




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.1.3-34**
**SCHEMATIC OF PROPOSED CONTROL SYSTEM**

the system and a Graphics Display Board for the entire plant. Current plant status will be displayed here. The CPU will receive and store input from the maintenance center, plant security, plant laboratory, and the four main control centers. The CPU will also be used for administrative requirements. The system will be capable of generating daily, weekly and annual reports summarizing plant operating data. Process control staff, administrative staff, and laboratory staff housed within the Operations Management Center will have computer workstations linked to the CPU.

The shift supervisor will be responsible for the entire plant operation and implementation of process control/operating decisions made by process control personnel at the Operations Management Center. Implementation will be achieved via directions communicated to the operators in the four process control centers. This could be done by means of CRT, printer, messages, or direct telephone communication.

The shift supervisors will be housed in the primary treatment control center since the operations management center will be staffed only on a 40 hr/week basis. The shift supervisor's office area will include CRTs, keyboards, and printers allowing access to the CPU. This area will also include a Graphics Display Board similar to that provided in the Operations Management Center.

Each of the control centers will be provided with a DPU housed in an air conditioned control room which will also function as an office for control center supervisors. Each control center will be provided with a Graphics Display Board showing status of equipment controlled through that center. The center will have a keyboard, two CRTs and two printers to allow access to the CPU for data and status reports pertaining to other portions of the plant. One printer will be provided for reports and one for alarm and event recording. At the DPU level, the operator will have full capability to start and stop equipment, change cycle times, adjust set points, and acknowledge alarms through the CRT/keyboard. The start/stop capability will be built in, but provisions will be made for security codes to selectively lock out this capability at this level if management should decide that start/stop of equipment should be performed at the LPU level. The operators in the main control centers will have access to displays and information from other areas of the plant. However, control capability will be restricted.

Local control panels provided throughout the plant will include internally mounted LPUs (microprocessor with programmable controllers). These will be dedicated to specific unit processes, or groups of process equipment. These LPUs will be linked via data highways to the respective DPUs located in the Main Control Centers. All equipment will be wired directly to the local panels. Each Local Control Panel will be provided with manual override control capability. DPUs will be linked to redundant CPUs via high-speed data highways.

Each level of control within the distributed digital control system will be capable of operating completely independent of the next higher level. If the redundant CPUs in the Operations Management Center fail, the plant could still be operated with no degradation of control functions from the main control centers. If a DPU fails at a main control center, it would be possible to operate that portion of the plant from the local control panels. Each LPU

would be capable of operating completely independently so that an operator could make process changes at the local panel by means of a portable CRT, with no degradation of control. Alternatively, the operator could utilize the local manual backup controls which would be completely independent of the digital system. This mode would result in some degradation of control since all interlocks and automatic functions implemented in the digital system would be bypassed.

Control Hierarchy. In general, all plant operation and control will be accomplished through operation interface review at the DPU level or through conventional monitoring and control services at the local control panels.

Local-Remote and Start/Stop/Lockout switches at motors, or at the motor control center, are provided for maintenance purposes only and are not intended to be used for normal operations. These switches will be wired to LPUs to alert plant operating staff that a device has been removed from service for maintenance purposes.

Safety or protective interlocks for motor driven devices will be implemented with hard wired devices at motor control centers, and will require manual resetting. Automatic function will be implemented in software at the LPU and/or DPU level.

Disagreement alarms will be provided to alert operators at both the DPU level and the LPU level of equipment failure or unauthorized operation of equipment at another level in the hierarchy.

Administration, Laboratory, and Operations Management Building Complex

The administrative staff, the operations manager and staff including process control personnel, and the laboratory staff will be located within a building complex composed of the rehabilitated old steam pumping station, newly constructed wings, and connecting passageways to the treatment plant main process area.

The required gross floor areas were developed based on the recommended organizational structure for the plant's staff and an analysis of related space needs. Space is required for a staff of 40 persons associated with plant administration, including offices for the plant superintendent and the manager of the administrative staff. Space for a staff of 11 persons associated with the operations manager, including offices for the operations manager, offices for four assistant managers (one each for headworks, primary, secondary, and residuals), as well as space for the process control staff, is required. Space is also required for the lab manager and his staff of 14. Space needs for staff include offices for managers and administrators, and cubicles for support staff and technicians.

Related space needs for the administrative area include a reception/lobby area, records storage, plan file room, copy center, switchboard, conference rooms, and a training/presentation auditorium. Related space needs for the operations management area include a conference room, and a main control room which will house the graphic display board for the plant and the central computer for the entire facility. The laboratory area's related

needs include the actual lab facilities which include sample receiving, wet chemistry laboratory, organics laboratory, inorganics laboratory, storerooms, washrooms, bacteriological laboratory, whole effluent toxicity laboratory, and an experimentation/pilot facility laboratory.

The total area requirements for administration are approximately 25,500 $ft^2$ of gross area. The total area needs for the operations management are approximately 4,500 $ft^2$ of gross area. The total area needs of the laboratory facilities are approximately 20,000 $ft^2$.

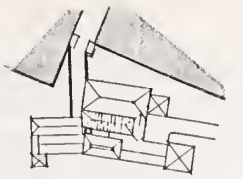
The available floor space within the existing old steam pumping station is approximately 20,000 $ft^2$ of area. The existing structure is depicted in Figure 11.4.7-2 later in this section. The recommended plan is to rehabilitate this structure for administrative needs. The laboratory and operations management have unique building needs associated with chemical handling and disposal in the laboratory, and computer security and operations in the operations management area. New wings will be added to the existing steam pumping station structure for these areas. The proposed new and rehabilitated facilities are depicted in Figure 11.1.3-35.

Subject to a detailed inspection, the old steam pumping station structure appears to be sound. Constructed in four stages, it is an excellent example of the finely crafted public buildings of its era. Its conversion to administrative offices affords an opportunity to provide an historical link from its original sewage pumping function at this location, to its contemporary technological function. The scale, the warm brick facade, the window style, construction, and placement, and the sloping roofs of this former pumping station make it, overall, an aesthetically pleasing structure. It is eminently suited to housing the administrative staff and can also act as a focal point for visitors touring the plant. Its location close to the docks, the access road, and the internal tunnel circulation of the treatment plant is favorable. This structure will be retained and converted for use as the administrative area, with the addition of a partial second floor to provide an additional 5,000 $ft^2$.

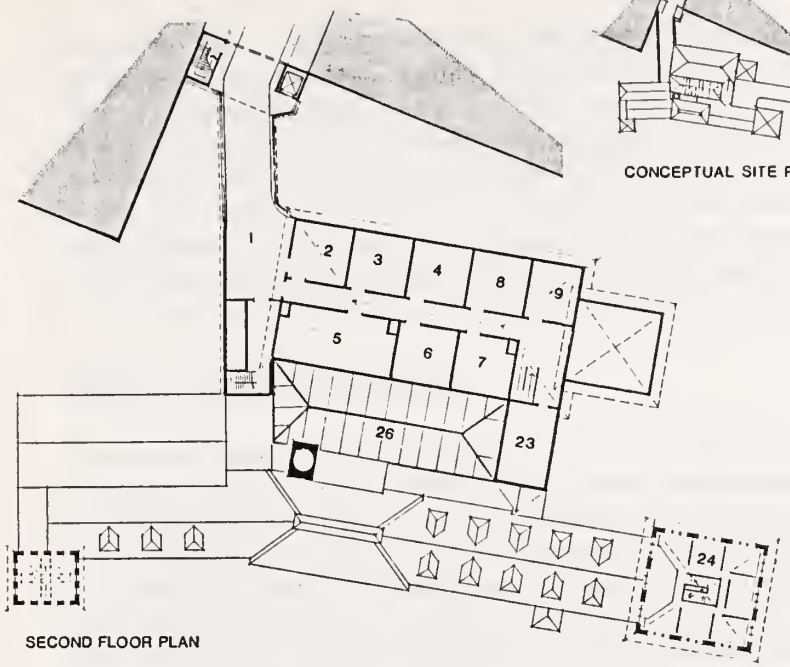
Extensive demolition in the interior will be required to achieve this conversion, including the removal of large cast iron boilers, the concrete structure in the former coal bin, and screening chambers. The engine pits will be decked over. Exterior shell renovations will include replacement of windows and doors, reroofing, and cleaning, patching and pointing of masonry. New mechanical and electrical systems will be required, suitable for office and public assembly occupancy, as well as partitions, interior finishes, and restroom facilities.

The new administration building will also function as a visitors' center. It will be the predominant architectural structure exposed to public view, and will welcome visitors to the facility. It is intended to provide a pleasant atmosphere for visitors, as well as a spacious working environment for the administrative staff.

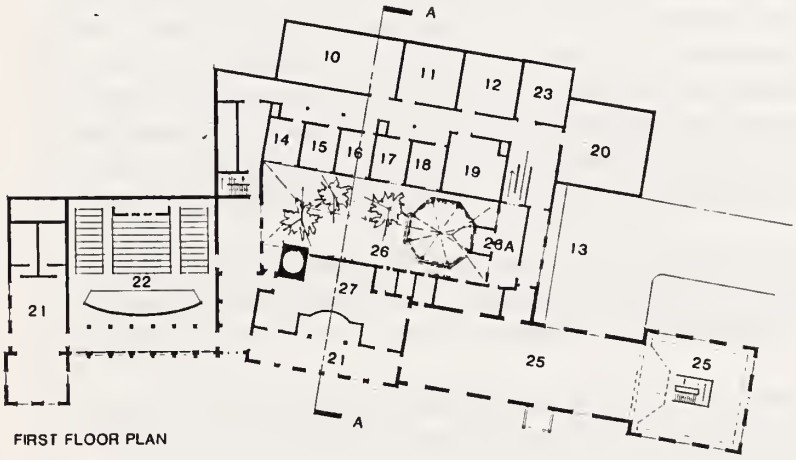
The laboratories will handle regular and routine samplings from the treatment plant, and thus will require direct, enclosed access from the plant. The laboratory staff will interact with the administrative group and will participate in its record-keeping functions. Therefore, it



CONCEPTUAL SITE PLAN




SECOND FLOOR PLAN




FIRST FLOOR PLAN

LABORATORY
1 Entrance Foyer
2 Sample Receiving
3 Process Leb
4 Wet Biology Leb
5 Wet Chemistry Leb
6 Organics Leb
7 Inorganics Leb
8 Washroom
9 Toilet/Storage
10 Whole Effluent Toxins
11 Toilet/Storage
12 Dry Storeroom
13 Service
14 Process Supervisor
15 Organics Supervisor
16 Inorganics Supervisor
17 Leb Supervisor
18 Leb Records
19 Chemical Storeroom
20 Pilot Experimentation Room (2 Story)

SECTION A-A

ADMINISTRATION
21 Public Space
22 Training Room/Auditorium
23 Record Keeping
24 Conference Rooms/ Offices
25 Administrative/ Open Secretarial Space
26 Courtyard / Cafeteria 26A Kitchen
27 Plant Operation Administration & Control

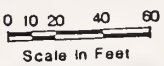



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**FIGURE 11.1.3-35**
**RECOMMENDED FACILITIES - ADMINISTRATION, LABORATORY AND OPERATIONS MANAGEMAENT**

is proposed that the laboratories be located between the plant and the converted administration building, and that they serve as a link between the two. The laboratory wing shares a service court with the administration building. The lower laboratory level is at grade with the administration offices, and the upper level is at grade with the plant's circulation tunnel. The sample room and all of the laboratories have been organized on one level for efficiency in sample preparation and analysis. All of the storerooms and the laboratory employee space have been organized on their own level. It is proposed that the exposed exterior facade be clad in brick to match the administration building, with punched windows on the upper level for offices. The roof line of the new wings will match that of the existing pump house.

Maintenance and Storage Buildings

The organizational program for the operations and maintenance of the treatment facilities recommends that space be provided for a centralized maintenance facility, parts and supply warehouse, and vehicle storage and maintenance. These recommended facilities are sited along the western side of the treatment facilities between the administration building and the north main pumping station. The maintenance facilities as shown on the recommended plan consist of three buildings. All three buildings are two stories in height. Internally the space is single story height for office, lunchroom, small parts storage, and several of the maintenance areas. Portions of the internal space will be a two-story high working area, these areas include vehicle maintenance and large parts storage. The storage and maintenance facilities first floor elevation is at the same elevation as the treatment facilities internal passageways. Externally the maintenance facilities will be accessible at both the ground floor elevation of 125 ft and from the upper story elevation of 140 ft. This would be accomplished by providing truck bays and or access to each of the two levels from two sides of the building.

The space needs program for the maintenance facilities has five areas - maintenance administration and personnel area; maintenance and repair shop areas; vehicle maintenance and grounds maintenance area, small parts storage and warehousing; and a large parts storage area.

Based upon the recommended organizational program, the maintenance staff at Deer Island will be approximately 250 persons. Some of the staff will be assigned to work areas throughout the plant, and/or remote headworks. Most of the maintenance staff will work directly at or out of the maintenance facilities.

The area for maintenance administration and personnel needs is approximately 22,500 sq ft. These facilities include offices for the maintenance manger, chief maintenance engineer, scheduler, a conference room, a record storage area, mens and womens locker rooms sized for 250 men and 50 women, and a lunch room. All of this area is proposed as single level space.

The area for the maintenance shops is 24,000 $ft^2$. The maintenance shops will be provided with truck bays for external access, and/or large doorways that access a corridor directly connects to the internal passageways of the plant. Eight thousand square feet of the space has been allocated for general maintenance, within that space would be approximately 15 work stations furnished with appropriate cranes, lifts, workbenches and tools. This area would be

utilized for general assembly and disassembly of equipment. Specialized maintenance shops each sized at approximately 1500 sq. ft. include; a welding shop; a machine shop capable of handling medium sized equipment; a carpentry shop; a metalworking shop; a paint shop; a 480 volt electrical shop; a 13.8 volt electrical shop; an instrumentation lab; and a heating ventilation and air conditioning shop.

An area of approximately 20,000 sq ft is included for a garage facility for the maintenance of plant vehicles and the storage of grounds keeping equipment such as mowers, and snow removal equipment. Approximately half of this area is expected to be a two-story internal space for either the vehicle maintenance lifts or storage of oversized equipment. Included within this vehicle maintenance area would be the facilities associated with the electric carts used for movement within the internal passageways.

The maintenance facilities also include space for warehousing and storage. The recommended warehouse and storage facilities require approximately 75,000 sq ft of area. The warehousing operation will consist of bin storage and pallet storage of all the spare parts and repair parts for the facility with the exception of oversized parts which would require either a craned or hoist to move. The oversized parts would be housed in an attached two-story high storage area.

Earthwork

The total site excavation for the recommend plan is approximately 4,200,000 cu yd. Up to an additional 2,000,000 cu yd of material will be excavated from the inter-island tunnel, the outfall, and demolition debris. Approximately 4,700,000 cu yd of material will be needed to construct the recommended Deer Island landforms. The material for the landforms will be obtained from both the site excavation and the additional tunnel material. The landforms will be constructed as excavation becomes available.

Excavation is expected to commence in 1988 with the leveling of the southeastern portion of the island's main drumlin to elevation 125 ft, as stated in Volume VI, Early Site Preparation. This material will be moved northward and southward to the areas of the proposed landforms, raising those areas to a minimum elevation of 125 ft, generating a common working elevation for the site.

As dictated by the recommended construction schedule, additional areas will be excavated for the construction of primary treatment facilities, disinfection, and all associated conduits and operating facilities. The excavated material will be used to continue raising the landforms to their proposed final elevation, beginning by completing the southern landform, then continuing with the northern, and largest landform. Completion of all major new landforms is expected by mid-1996. Excavated volumes were multiplied by a bulking factor of 15 percent to determine the volume of material that would be available as fill. These volumes are presented in Table 11.1.3-8.

The material excavated on-island is assumed to be inappropriate for use as structural fill for construction of the treatment facilities. This material must be acquired from another source.

## TABLE 11.1.3-8

## SUMMARY OF EXCAVATION REQUIRED FOR RECOMMENDED PLAN

| Excavation Location | Excavation Volume Removed Including 15% Bulking Factor (CY) |
|---|---|
| Main Drumlin | 3,000,000 |
| Abandoned Bunkers | 40,000 |
| Primaries | 220,000 |
| Aeration | 250,000 |
| Secondaries | 615,000 |
| Disinfection | 50,000 |
| Grit and Screenings | 85,000 |
| Existing Plant Demolition | 120,000 |
| Piers | 150,000 |
| Inter Island Tunnel | 200,000 |
| Outfall Tunnel* | 1,700,000 |
| TOTAL | 6,430,000 |

*Based on upper range of outfall options.

It is assumed that all areas that must be filled to attain the appropriate base slab elevation will be filled with structural fill. Furthermore, it is assumed that structures are surrounded horizontally by 3 ft of structural fill and 2 ft of structural fill on the underlying surface. Based upon these assumptions, the volume of structural fill required for each of the processes is presented in Table 11.1.3-9.

The landforms will be constructed around the perimeter of the island for both practical and aesthetic purposes. These landforms will help protect the facilities and employees from the harsh New England weather, while providing a relatively scenic view of the site from Boston Harbor and the town of Winthrop. The landforms will be created from the material that is generated from excavation activities, and the volumes of material pertaining to them have been divided into three main areas: north landforms, eastern landforms, and southern landforms.

The north section is the largest landform, using about 79 percent of the available material. It consists of a new drumlin rising to elevation 240 ft connected to a semicircular ridge of gradually lower elevations, which curve along the northern shoreline and across the town line into Winthrop. This ridge encloses a flat, protected area at an elevation of approximately 130 ft. Currently lying within the north section of the landform is a cemetary that is considered a historic site. It is assumed that the site can be buried, however it has not been formally determined whether this is acceptable. Calculations have been made for both options. Should additional cover be precluded, there would be an aditional 160,000 cu yd to dispose off-site. The east side of the island will consist of three distinct highpoints at an approximate elevation of 155-160 ft. These high points have been constructed to allow for air circulation around the cryogenic units that are located in the area. The east section will involve 8 percent of the available material. The south section consists of a ridge that is a continuation of the eastern shore landform. The ridge follows the shoreline to the southern tip of the island where a small drumlin will be located on top of the relocated grit and screening landfill. The remainder of the southern section (designated for residual needs) will be filled to an elevation of 125 ft, except for those areas required by the pier facility. The amount of material for the south section represents 13 percent of that available.

Landform volumes presented in Table 11.1.3-10 are based on the assumption that slopes can be constructed at a 2:1 (horizontal to vertical) ratio. It is further assumed that the landforms could be built beginning from the high-water line of elevation 110 ft. It should be noted that although the volumes have been separated into the three areas, the landforms are not separate entities, but are related and connected in a smooth, systematic fashion.

Landscaping

The proposed peripheral landforms are to be covered by vegetation. The objective of the landscaping program is to establish a ground cover of grass, shrubs, and trees that are indigenous to the harbor islands. The landscaping will stabilize the earth surface, provide additional visual screening, and encourage the establishment of coastal wildlife. There are two main areas to consider for proposed vegetation: the meadow area, located between the Winthrop town line and the treatment facilities; and the drumlins, which are located along the perimeter of the island and also surround the meadow.

TABLE 11.1.3-9

SUMMARY OF STRUCTURAL FILL FOR RECOMMENDED PLAN

| Location | Structural Fill During Site Preparation ($yd^3$) | Structural Fill During Plant Construction ($yd^3$) | Total Structural Fill ($yd^3$) |
|---|---|---|---|
| Primaries | 17,000 | 76,000 | 93,000 |
| Aeration | 24,000 | 44,000 | 68,000 |
| Secondaries | 0 | 80,000 | 80,000 |
| Disinfection | 0 | 10,000 | 10,000 |
| Total | 41,000 | 210,0000 | 251,000 |

## TABLE 11.1.3-10

## SUMMARY OF SURPLUS EXCAVATION VOLUME RECOMMENDED PLAN

| Item | ($yd^3$) |
|---|---|
| Northern Landform | 3,720,000 |
| Eastern Landform | 360,000 |
| Southern Landform | 630,000 |
| Total Landforms | 4,710,000 |
| Total Excavation | 6,430,000 |
| Surplus Excavation | 1,720,000 |

The meadow is a level, largely open area that will be planted with hardy clustered groupings, consisting mainly of grasses with some trees for shade. It is expected that the meadow will be mowed regularly.

The landscaping of the perimeter drumlin will eventually consist of fairly dense groupings of trees and shrubs. Native grasses will complete the ground coverage. These areas would not require significant maintenance, once established, and would be allowed to develop as natural plant communities.

The establishment of the proposed vegetation will occur, by necessity, in stages. It is not possible to plant certain trees or shrubs and expect them to survive in the environment that will initially exist on the island. Therefore, hardy grasses and plants that are more acclimated to survival in a harsh environment should be introduced to the area first. Once these have become established, additional species of trees and shrubs may be introduced to the area. These plants will have a greater potential for survivial due to the protection afforded by the existing vegetation.

Table 11.1.3-11 is a list of recommended vegetation. The majority of the plants are either native to or have become naturalized to the region, and most provide food for wildlife. Those that are most hardy and suitable for the earlier stages of landscaping have been marked with an asterisk (*). Plants not indicated should be considered for later stages only. Varieties of plants should be planted in groups that grow together naturally, so that a self-sustaining community may develop.

### 11.1.4 PILOT TESTING PROGRAM

The sizing of the recommended treatment facilities were based on unit process design criteria which have been demonstrated in full-scale municipal wastewater operations. The facilities ultimately constructed must be adequately sized to provide reliable, flexible, cost-effective treatment to the highly variable MWRA wastewaters. However, because of the scale of the recommended MWRA facilities, relatively small variations in design criteria can result in substantial impacts upon capital costs.

To ensure that the constructed facilities are optimally sized to provide the required levels of reliable treatment and operation while minimizing the authority's capital investment, the final design criteria for the recommended facilities should be established via pilot operation of the proposed unit processes using MWRA wastewaters. The pilot program should be constructed to investigate the following:

1. The results of the Fall 1986 and Spring 1987 sampling programs indicated that the existing North System and South System wastewaters are essentially identical in organic characteristics and both are typically domestic in nature. Preliminary piloting should be performed to ensure that the treatability and resulting sludges of the separate wastewaters are the same as the treatability of the mixed wastewaters which will be jointly treated once the new facilities are constructed. If the results of this preliminary piloting indicates that the treatability and sludge characteristics of the separate wastewaters are identical to that of the mixed

## TABLE 11.1.3-11

## RECOMMENDED TREES AND SHRUBS FOR LANDSCAPING PROGRAM

Trees:

Amelanchier canadensis - Downy Shadblow
Betula lenta - Sweet Birch
Betula populifolia - Gray Birch
Crataegus crus-galli - Cockspur Hawthorn
Eleaghus angustifolia - Russian Olive
Juniperus virginiana - Eastern Red Cedar
Nyssa sylvatica - Black Tupelo
Pinus rigida - Pitch Pine
Pinus nigra - Austrian Pine
Pinus sylvestris - Scotch Pine*
Pinus thunbergii - Japanese Black Pine
Populus tremuloides - Quaking Aspen
Populus grandidenta - Big Tooth Aspen
Prunus americana - American Pium
Prunus pensylvanica - Pin Cherry
Prunus serotina - Black Cherry*
Prunus virginiana - Choke Cherry*
Quercus alba - White Oak
Quercus rubra - Red Oak
Robinia pseudoacacia - Black Locust
Tilia americana - American Basswood
Sambucus canadensis - American Elder
Acer platanoides - Norway Maple
Acer pseudoplatanus - Sycamore Maple
Acer rubrum - Red Maple

Shrubs

Arctostaphylos uva-ursi - Bearberry
Clethra alnifolia - Summersweet
Cornus sericea - Red Osier Dogwood*
Cytisus scoparius - Scotch Broom
Myrica pensylvanica - Bayberry*
Pinus mugo mugo - Mugo Pine
Prunus maritima - Beach Plum*
Prunus cistena - Purple Leaf Sand Cherry
Potentilla fruiticosa - Bush Cinquefoil

## TABLE 11.1.3-11

## RECOMMENDED TREES AND SHRUBS FOR LANDSCAPING PROGRAM

Rhus typhira - Staghorn Sumac*
Rosa blanda - Meadow Rose
Rosa nitida - Shining Rose
Rosa rugosa - Rugosa Rose*
Rosa virginiana - Virginia Rose
Salix reopens - Creeping Willow
Syringer vulgvaris - Common Lilac
Vaccinium corymbosum - High Bush Blueberry
Viburnum dentatum - Arrowwood Viburnum

* More likely to survive in harsh environments

wastewaters, then the subsequent pilot work can be performed on Deer Island using only North System wastewaters. Otherwise, wastewater from the South System will have to be transported to Deer Island for the pilot work.

2. The stacked primary and secondary clarifiers should be piloted to determine optimum configurations. The scale of the pilot facilities should be determined with the assistance of a dynamic similitude analysis. The effect of seasonal flows and temperatures, storm-flows, and variation in chloride levels should be specifically addressed with regard to inlet and outlet configurations and baffling requirements.

3. Primary and secondary sludge production rates and sludge characterizations should be established. This information is essential to the design of residuals handling and disposal facilities. The removal rates of metals and priority pollutants should be established.

4. Currently there is presently limited information available on the release of volatile organics from wastewater to the atmosphere during the various treatment sequences. Expected release rates should be determined through actual piloting. Attention should be directed to the production and release of volatile organics in the activated sludge process.

5. The use of an anaerobic selector versus a high F/M oxic selector (using pure oxygen) should be investigated. The piloting should include optimization of the first stage of the oxygen activated sludge train so that it more adequately serves as a selector. This might be achieved by further compartmentalization of the first stage to increase the initial F/M. Operating stability under varying load and flow conditions should be evaluated for the anaerobic and oxic selectors prior to making a final determination of selector type. Optimum selector volumes and sludge settling characteristics should be determined.

6. The oxygen activated sludge process should be piloted, in conjunction with the selector, to determine minimum SRT levels; oxygen input requirements; rate coefficients for BOD removal, sludge production and oxygen utilization; and clarifier underflow concentrations. The impact of variations in F/M due to storm-related flows and loads should be determined.

7. In conjunction with obtaining the above design parameters, the pilot facilities could also be used for operator and/or process control training.

In conjunction with the piloting, the MWRA should implement a program whereby operating results from other facilities in the United States with similar equipment are continually reviewed for input into the final design criteria.

The specific timing, details, and size of the pilot program should be developed as part of the overall implementation program. While the bulk of the piloting is with the secondary facilities, it is important to proceed with the pilot program within a schedule that allows design of the Deer Island Facilities to proceed in a timely fashion.

## 11.2 CONSTRUCTION CONSIDERATIONS

### 11.2.1 MAINTENANCE OF PLANT OPERATIONS DURING CONSTRUCTION

Deer Island

This section describes the sequence, schedule and procedures required to maintain the operation of the existing Deer Island treatment plant during the construction of the new facilities at Deer Island. This section also describes the methods that will be used to convey wastewater flows to the new treatment facilities. The following existing facilities have been identified as those that must be maintained and upgraded during the construction of the new treatment facilities: the North Main Pumping Station, Winthrop Terminal, the plant water system and the power facilities. Other facilities required to implement operation of the new treatment facilities include: force mains to convey discharge flows from the North Main Pumping Station and Winthrop Terminal to the new North grit facilities, an interim disinfection facility in the event that the new disinfection facilities are not available when the new primary facilities are on-line, and a South System Pumping Station for lifting south flows from the new inter-island conveyance system to the Deer Island Treatment Facilities.

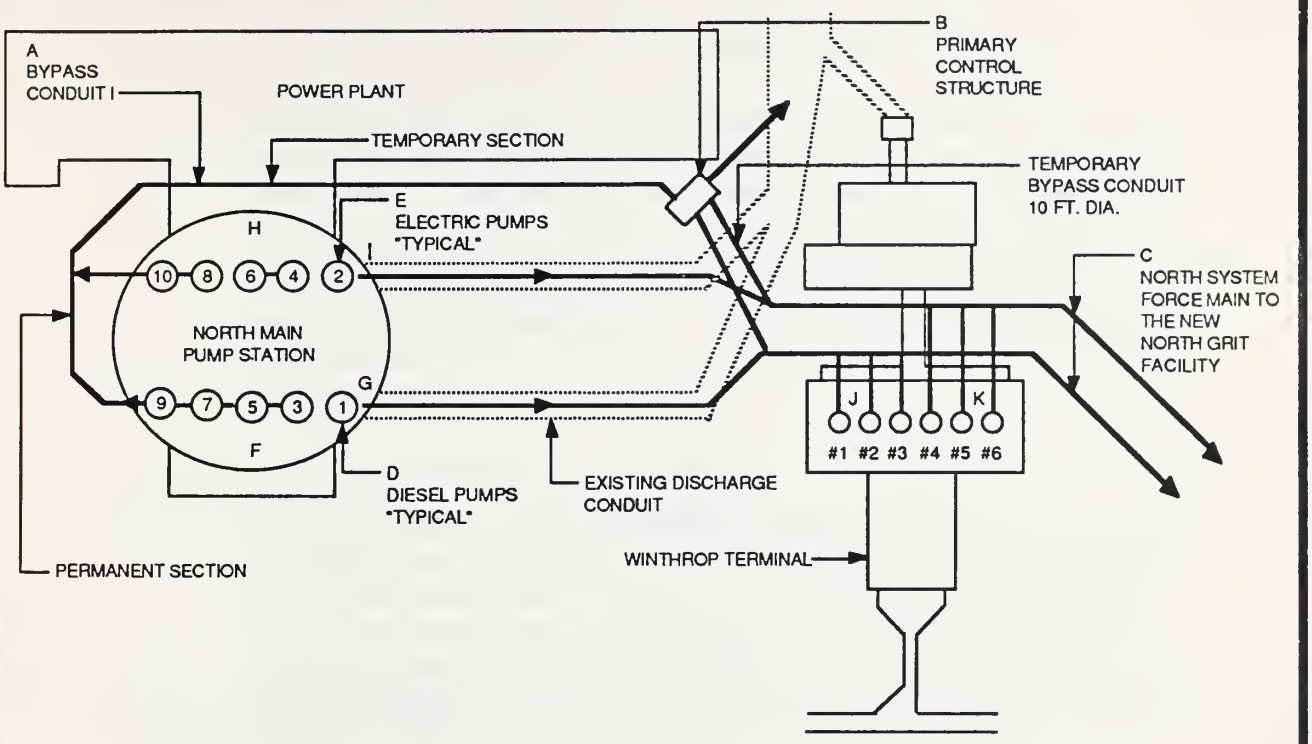
The required modifications to the existing facilities are described later in this section. These modifications are required beyond those of the Fast-Track Improvements Program currently in progress.

North System Modifications

The North System facilities (the North Main Pumping Station and Winthrop Terminal) require numerous modifications in order to lift the wastewater flow to elevation 158. Two alternative modification schemes were evaluated, and are presented in this section. The differences between alternatives are the associated costs and the duration of decreased pumping capabilities of the North Main Pumping Station. Alternative I, which costs an additional three million dollars, allows completion of the required modifications while maintaining eight operating pumps at the North Main Pumping Station, except for two 7-day periods during which only five pumps would be available. Under Alternative II, the required modifications would be completed with only five operable pumps for 30 days at the North Main Pumping Station. Either Alternative I or II could be used. The MWRA should evaluate the additional costs associated with Alternative I versus the increased pumping capacity available during the station modifications. Alternative I would also result in increased flexibility following completion of the project by allowing the pumps on either side of the Main Pumping Station to discharge to either of the new North System force mains (and to either of the new North System grit batteries).

Modification of the North System Facilities: Alternative I

The construction sequence for Alternative I is briefly described below and is shown in Figure 11.2.1-1. The detailed description for each modification is discussed in the facility modification subsection. The proposed construction sequence for modification to the North Main




LEGEND

A. CONSTRUCTION OF THE NORTH MAIN PUMP STATION DISCHARGE BYPASS CONDUIT
B. CONSTRUCTION OF THE PRIMARY CONTROL STRUCTURE
C. CONSTRUCTION OF THE FORCE MAINS TO THE NEW NORTH GRIT FACILITY
D. REPLACEMENT OF THE DIESEL PUMPS IN THE WESTERN PORTION OF THE NORTH MAIN PUMP STATION (REPLACEMENT OF THE ODD NUMBERED PUMPS)
E. MODIFICATION TO THE ELECTRIC PUMPS IN THE EASTERN PORTION OF THE NORTH MAIN PUMP STATION (REPLACEMENT OF THE EVEN NUMBERED PUMPS)
F. MODIFICATION TO NORTH MAIN PUMP STATION WESTERN DISCHARGE MANIFOLD
G. CONNECTION OF THE WESTERN HEADER TO THE NEW FORCE MAIN
H. MODIFICATION TO THE NORTH MAIN PUMP STATION EASTERN DISCHARGE MANIFOLD
I. CONNECTION OF THE EASTERN HEADER TO THE NEW FORCE MAIN
J. WINTHROP TERMINAL: PHASE I
K. WINTHROP TERMINAL: PHASE II

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**FIGURE 11.2.1-1**
**CONSTRUCTION SEQUENCING FOR THE NORTH SYSTEM MAINTENANCE ALTERNATIVE 1**

Pumping Station and Winthrop Terminal under Alternative I is as follows:

A) Construction of the North Main Pumping Station discharge bypass conduit.

On the north side of the Main Pumping Station, a conduit would be constructed in order to bypass flow around existing discharge conduits. All flows from the Main Pumping Station would still be discharged to the existing primary plant. This bypass conduit would be used when the force mains to the new North grit facilities are tied into the pumps' discharge headers. The bypass conduit would include a permanent 10-ft-diameter section, approximately 120 ft, long and a temporary section 12 ft in diameter and approximately 250 ft in length. The two sections of the conduit would be connected, and would pass under the existing power plant and end at the primary control structure described below.

B) Construction of the primary control structure.

The primary control structure will be used to transfer flows from the three bypass conduits (the one from the North Main Pumping Station and the other two, which transfer flow from the new force mains) to the existing primary treatment facilities. The primary control structure is approximately 15 ft by 35 ft. Also, during this construction task, the two temporary 10-ft-diameter conduits which convey flows from the new force mains to the existing treatment facility (through the primary control structure) would be constructed.

C) Construction of the force mains from Winthrop Terminal to the new North grit facility.

Two 11.5-ft-diameter concrete conduits will be constructed from the east of Winthrop Terminal to the new North grit facility. The conduits are each 2800 ft in length and run along the western side of Deer Island. This construction is independent of the modifications to the North Main Pumping Station and Winthrop Terminal until the new connections are required (Flows G, N, and I).

D) Replacement of the diesel pumps in the western portion of the North Main Pumping Station.

Task D calls for replacement of the odd-numbered pumps located in the western portion of the pumping station with new electrical pumps, casings, impellers, motors, and drives. Associated suction and discharge piping and valving modifications shall be done in conjunction with the prospective pump modifications. Modifications would be done to one pump at a time.

E) Modification of the electric pumps in the eastern portion of the North Main Pumping Station.

Task E calls for modification of the even-numbered pumps located in the eastern portion of the pumping station.

New pump impellers will be installed in the existing pumps. A new electric motor and drive will be provided for each pump. New knife gate valves will be installed on each discharge line. Modifications would be done to one pump at a time.

F) Modification to pumps' western discharge manifold.

The North Main Pumping Station's western side will be taken out of service for up to 7-days in order to isolate and modify the discharge manifold. The manifold would be connected to the discharge bypass conduit described as Task A. A new valve would be installed in the manifold between pumps #3 and #5.

To implement this modification, the existing western discharge conduit would be isolated with stop logs. This prevents backflow from the existing eastern discharge conduits.

G) Connection of the western discharge header to the new force main.

In order to implement this modification, flow from pumps #5, #7, and #9 would be discharged through the bypass conduit and the primary control structure to the existing treatment facility. Pumps #1 and #3 would be unavailable during this modification. The western discharge manifold from the North Main Pumping Station shall be connected to the west force main connection to the new North grit facilities. Also, the connection to one of the 10-ft-diameter bypass lines from the new force main to the primary control structure described in Task B shall be constructed.

H) Modification to the pumps' eastern discharge manifold.

The North Pumping Station's eastern side will be taken out of service for 7-days in order to isolate and modify the discharge manifold. The manifold would be connected to the discharge bypass conduit described in Task A. A new valve would be installed in the manifold between pumps #4 and #6.

To implement this modification, the existing eastern discharge conduit would be isolated with stop logs.

I) Connection of the eastern discharge header to the new force main.

In order to implement this modification, flow from pumps #6, #8 and 10 would be discharged through the bypass conduit and the primary control structure to the existing treatment facility. Pumps #2 and #4 would be unavailable during this modification. The eastern discharge manifold from the Main Pumping Station shall be

connected to the east force main's connection to the new North grit facilities. Also, the connection to the other 10-ft-diameter bypass line from the new force main to the primary control structure described in Task B shall be constructed.

J) Winthrop Terminal: Phase I.

Phase I of the Winthrop Terminal modification consists of dewatering Wet Well I in preparation of structural repairs. Simultaneously, pumps #1, #2, and #3 shall be taken out of service and replaced with three 32 mgd pumps. The discharge lines from these pumps will be connected to the western force main discharging to the new North grit facilities.

K) Winthrop Terminal: Phase II.

Phase II of the Winthrop Terminal modifications consists of dewatering Wet Well II in preparation for structural repairs. Simultaneously, pumps #4, #5, and #6 shall be taken out of service and replaced with three 32 mgd pumps. The discharge lines from these pumps will be connected to the eastern force main.

Detailed Description: Facility Modification Alternative I

North Main Pumping Station. The North Main Pumping Station currently houses nine 90 mgd pumps. As part of the Fast-Track Improvements Program, a tenth 90 mgd pump will be added. To lift the wastewater flow to the new North grit facility, further modifications beyond those required by the fast-track program are necessary. Construction of the modifications has been scheduled to begin in January, 1990 and be completed before before January, 1993. Under Alternative I, eight pumps could be operable at all times (except for two 7-day periods) at the North Main Pumping Station for pumping of the North System storm flow. To meet this requirement, it will be necessary to isolate the pumps to allow for individual modification and to provide a bypass conduit to convey flows to the existing facility and to allow for connection of the new force mains to the existing header system.

The first modification planned at the North Main Pumping Station is the replacement of the five diesel pumps. The diesel engine drive pumps, including all associated piping and equipment, will be replaced with new electrical pumps including casings and impellers. These new pumps will each be rated at 90 mgd and 3000 hp and have variable speed eddy current coupling drives. The pumps will be replaced one at a time with complete modification done prior to commencing work on the next pump. About 30 days is required to remove the old pump, put in its replacement unit, and do miscellaneous pipe work.

Following replacement of the diesel pumps, the five electric pumps would be modified. Modifications include new impellers, motors, drives and discharge valving. Following modifications, each of the pumps will be rated at 90 mgd and 3000 hp. These pumps will also be replaced one at a time with complete modification done prior to commencing work on the next pump. About 30 days is required to modify a single unit.

The third modification to be done at the North Main Pumping Station is the isolation of the pumps located in the western portion of the pumping station. The pumps must be isolated in order to connect the discharge manifold to the new force main. Before commencement of the modification, the existing western discharge conduit must be isolated with stop logs. This prevents backflow from the eastern discharge conduit. The odd numbered pumps will be taken out of service for 7-days in order to modify the discharge manifold by installing a valve between pumps #3 and #5 and connecting the manifold to the bypass conduit. The bypass conduit consists of a 120-ft permanent section and a 250-ft-long temporary section. The permanent section of the bypass conduit is 10 ft in diameter and the temporary section is 12 ft in diameter. Both sections will be constructed of steel. In the future, the permanent section will allow the eastern (even-numbered) pumps to discharge to the new west force main and vice-versa. This will occur when the other force main, or new grit battery, is out of service for maintenance modifications. The bypass conduit runs around the north side of the North Main Pumping Station, curves east and passes between the power generation facility and the pumping station enroute to the primary control structure located near the existing eastern discharge conduit. A 78-in butterfly valve would be installed between pumps #3 and #5 in the area currently occupied by the Dresser coupling. This type of Dresser coupling would be installed between pumps #5 and #7. The manifold modification can be accomplished in 7 days. During the 7-day period, the eastern side of the pump station would be operating with a five-pump capacity. When the modification is completed, the five pumps taken out of service shall become operable and the pump station will be returned to full operation.

The fourth modification to the North Main Pumping Station is the connection of the western discharge manifold to the new western force main. This modification would be implemented by closing the valve installed between pumps #3 and #5 and opening the valve to the bypass conduit. This process transfers the discharge from pumps around the existing western discharge conduit, through the bypass conduit and primary control structure to the existing primary treatment plant. The closed valve takes pumps #1 and #3 out of service and allows for the manifold connection to the force main. A connection shall be provided to the new force main to allow transfer of flow from the force main to the existing treatment plant (via the primary control structure). The transfer pipline connection will be 10 ft in diameter and approximately 60 ft in length.

The fifth modification is the isolation of the pumps located in the eastern portion of the pumping station to connect the eastern discharge manifold to the bypass conduit. This modification would be identical to that previously described for the western pumps. A new 78-in butterfly valve would be installed between pumps #4 and #6 and a new Dresser coupling installed between pumps #6 and #8. The manifold modification can be accomplished in 7 days. During the 7-day period, the western side of the pump station would be available with five pumps. When the modification is completed, the pumping station is returned to full service.

The final modification to the North Main Pumping Station is the connection of the eastern discharge manifold to the new eastern force main. The process for the connection is identical to that described for the western manifold. The eastern force main will also have a 10-ft-diameter temporary pipeline to the primary control structure for transferring flows from

the new force main to the existing primary plant. During this modification, pumps #6, #8, and #10 would discharge to the bypass conduit. Pump #2 and #4 would be unavailable for service.

Winthrop Terminal. Winthrop Terminal currently houses four 15 mgd electric pumps and two 48 mgd diesel pumps. Various modifications to the pumping system are scheduled during fast-track improvements, including replacing the four 15 mgd pumps with four 23 mgd pumps. However, additional modifications to the pumping system are required in order to lift the flow to the new North grit facility. These modifications to the pumping station will be completed in two phases.

- Phase I

  During Phase I, pumps #1, #2, and #3 would be replaced with three 32 mgd electrical pumps. This modification requires the replacement of pumps, motors, impellers and miscellaneous equipment. Also during this phase, Wet Well I will require reconstruction of various inlet sections, and miscellaneous pipe work will be required in order to connect these pumps to one of the 11.5-ft-diameter force mains leading to the new north grit facilities.

- Phase II

  During Phase II, pumps #4, #5, and #6 would be replaced with three 32 mgd electrical pumps. The modification work required for this task is identical to the work described in Phase I. Also during this phase, miscellaneous pipe work will be required in order to connect these three pumps to the second North System force main.

An alternate way to modify Winthrop Terminal is as follows:

- Phase I

  Initially replace pumps #1 and #2 individually. Upon completion, dewater Wet Well I and do the miscellaneous structural modifications. Simultaneously, replace pump #3 and tie the discharge lines from all three pumps into the western force main.

- Phase II

  Initially replace pumps #5 and #6 individually. Upon completion, dewater Wet Well II and do the miscellaneous structural modifications. Simultaneously, replace pump #4 and tie the discharge lines from these three pumps into the eastern force main.

This alternate allows four pumps to be operating for the maximum amount of time.

Modification of the North System Facilities: Alternative II

The construction sequence for Alternative II is described below and is shown in Figure 11.2.1-2. The modification procedures for implementing Alternative II are primarily the same as those for Alternative I. The differences are the procedure for connecting the header system to the force mains, and extended durations with reduced pumping capacity at the North Main Pumping Station (maximum of five pumps are available for 30-60 days). The sequence of construction would be as follows:

A) Construction of the force mains to the new North grit facility. This construction will be independent of the modifications to the North Main Pumping Station and Winthrop Terminal until the connections to each station are required.

B) Replacement of the diesel pumps in the western portion of the North Main Pumping Station.

   The procedures for this construction task are identical to those for Alternative I (see Task D).

C) Modification of the electric pumps in the eastern portion of the North Main Pumping Station.

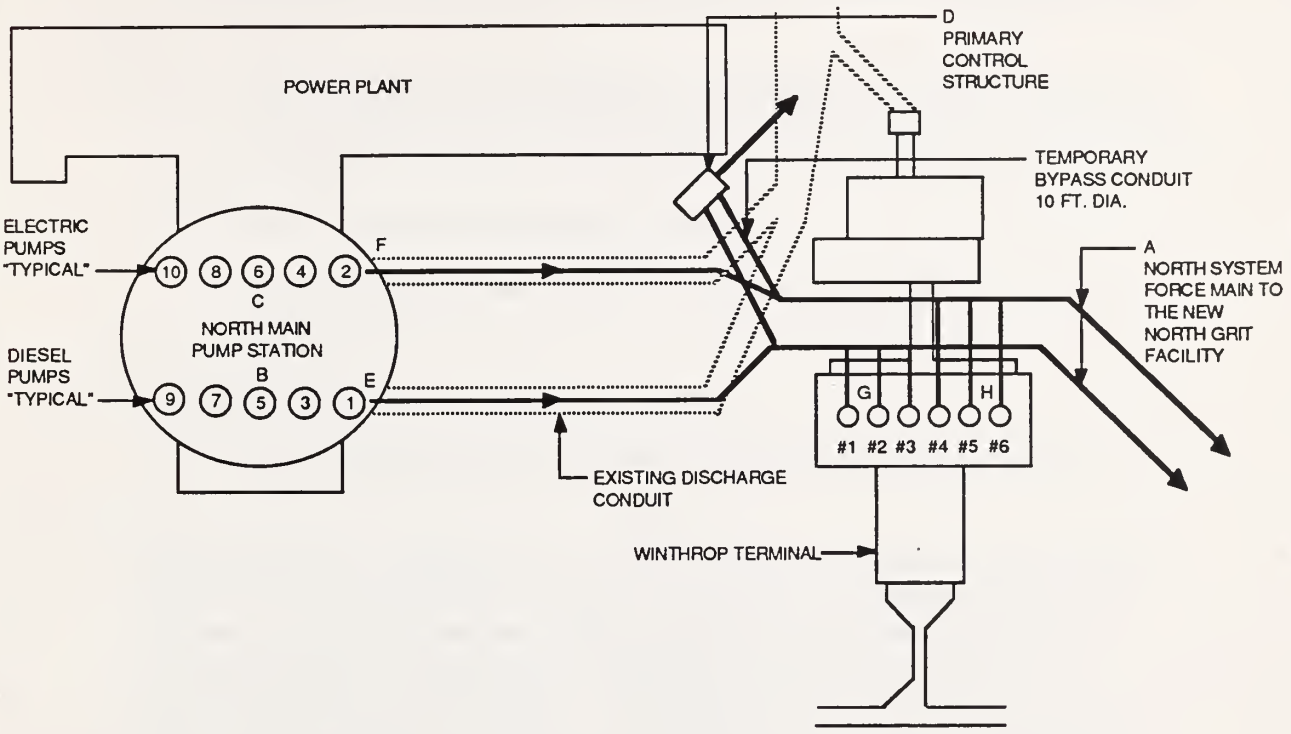
   The procedures for this construction task are identical to those for Alternative I (see Task E).

D) Construction of the primary control structure.

   The procedures for this construction task are identical to those for Alternative I (see Task B), except that there would be no North Main Pumping Station discharge bypass conduit connected to this box.

E) North Main Pumping Station: Connection of the western header to the western force main.

   This procedure constitutes the main difference between the alternatives for modifications to the North Main Pumping Station. To connect the header system to the force main, the western side of the pumping station (the odd-numbered pumps) will be taken out of service for at least 1 month. During this period, the following modifications will be done: 1) blockage of the existing discharge conduit with stop logs to prevent backflow from the existing eastern discharge conduit; 2) destruction of the existing western discharge conduit; 3) placement of the western force main in the area of the discharge conduit; and 4) the connection of the western header to the




LEGEND

A. CONSTRUCTION OF THE FORCE MAINS TO THE NEW NORTH GRIT FACILITY
B. REPLACEMENT OF THE DIESSEL PUMPS IN THE WESTERN PORTION OF THE NORTH MAIN PUMP STATION
C. MODIFICATION TO THE ELECTRIC PUMPS IN THE EASTERN PORTION OF THE NORTH MAIN PUMP STATION
D. CONSTRUCTION OF THE PRIMARY CONTROL STRUCTURE
E. NORTH MAIN PUMP STATION: CONNECTION OF THE WESTERN LEADER TO THE WESTERN FORCE MAIN
F. NORTH MAIN PUMP STATION: CONNECTION OF THE EASTERN LEADER TO THE EASTERN FORCE MAIN
G. WINTHROP TERMINAL MODIFICATION: PHASE I
H. WINTHROP TERMINAL MODIFICATION: PHASE II

| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.2.1-2<br>CONSTRUCTION SEQUENCING<br>FOR THE NORTH SYSTEM MAINTENANCE<br>ALTERNATIVE II |
|---|---|

force main. During these modifications, maximum pumping capability would be limited to the five eastern pumps.

F) North Main Pumping Station: Connection of the eastern header to the eastern force main.

The procedure for this construction task is identical to that required to connect the western header to the western force main, which is described above. During these modifications, maximum pumping capability would be limited to the five western pumps.

G) Winthrop Terminal Modification: Phase I.

The procedures for this construction task are identical to those for Alternative I (see Task J).

H) Winthrop Terminal Modification: Phase II.

The procedures for this construction task are identical to those referenced in Alternative I (see Task K).

Following completion of modifications to the North Main Pumping Station, according to either Alternative I or II, the ten pumps will be capable of lifting the North System influent flows to the new grit and primary treatment facilities, discharging to the existing primary plant, or a combination of both. This flexibility will allow for an orderly testing, start-up, and placing into permanent operation of the new treatment facilities. Flow control to the new or existing primary treatment facilities will be via the primary control structure constructed as part of the North Pumping Station modifications. This control structure will be subsequently demolished when the existing primary facilities are decommissioned and demolished.

Pumping of South System Flows

The court order has mandated that before March, 1995, South System flows must be discharged through the Deer Island outfall. To meet this requirement, scheduling requires that construction of the inter-island conveyance tunnel begin in 1990 and that completion of the tunnel work occur no later than October, 1994. Also, the construction of the South System Pumping Station on Deer Island and the Nut Island Headworks Facility shall be completed no later than December, 1994. Meeting this schedule allows for a six-month start-up period and assures that the system is operable by March, 1995.

In the event that the outfall is not available by March, 1995, the implementation of the mandate has two distinct possibilities: Case I: the South System Pumping Station, Nut Island Headworks Facility and the inter-island transport system are available for operation, but the new primary treatment plant at Deer Island and the new outfall are not available by March, 1995. Case II: the South System Pumping Station, Nut Island Headworks Facility and the

inter-island transport system are available for operation and the new primary treatment facilities are constructed and operable by March, 1995. However, the disinfection facilities and the new Deer Island outfall are not available. The suggested operating approaches to these alternatives are as follows:

Case I. Primary treatment and disinfection of South System flows would occur on Nut Island. Flow can either be discharged through the existing Nut Island outfall or it can be conveyed to Deer Island for discharge through the existing outfall. Conveying flow to Deer Island for discharge requires that a temporary conduit (14 ft x 14 ft) of 800 ft be constructed to convey flows from the South System Pumping Station to the existing outfall. The recommended alternative is to discharge the wastewater through the existing Nut Island outfall until the treatment facilities at Deer Island become available.

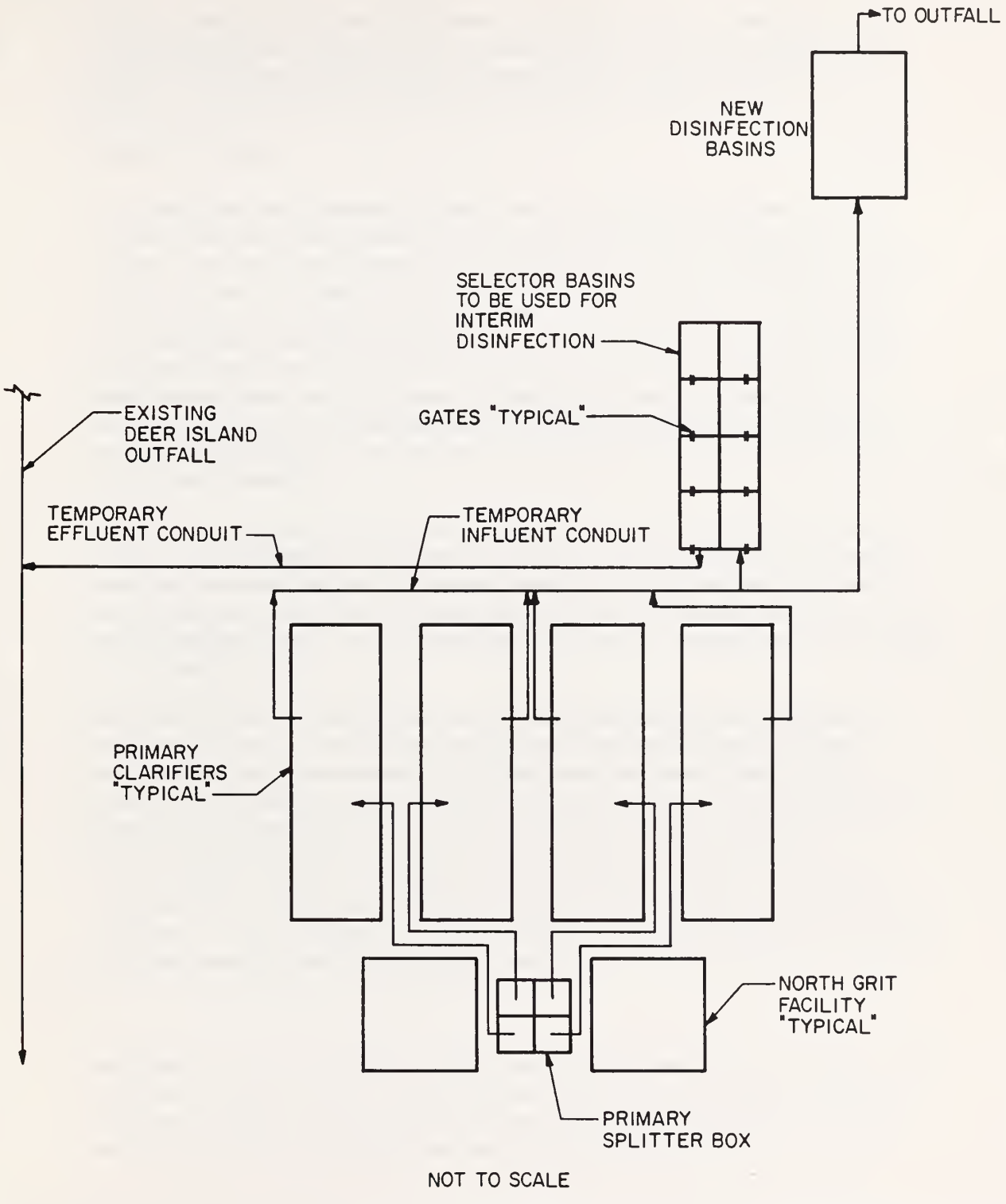
Case II. After preliminary treatment in the new Nut Island Headworks facility, the flow is conveyed to the South System Pumping Station and pumped to the primary splitter box. In the primary splitter box, the South System flow is mixed with the North System flow and both are distributed to the primary clarifiers. After treatment in the primary clarifiers, the flow is transferred to a temporary conduit for conveyance to an interim disinfection facility. After disinfection, the flow is conveyed by another temporary conduit to the existing Deer Island outfall.

Interim Disinfection

In the event that the new disinfection basins and outfall facilities are not available during the early years of operating the new primary treatment facilities, interim disinfection facilities will be required. The anaerobic selector zone process planned for use during secondary treatment could have eight of its sixteen basins used for interim disinfection during operation of the primary treatment plant. Each basin is 65 ft x 85 ft and has an 18-ft SWD. Sodium hypochlorite diffusers could be installed in each basin. The use of eight basins will allow for an 8-minute detention at the maximum flow of 1270 mgd. However, approximately 1800 ft of discharge conduit to the existing outfall would be provided. Therefore, the requirement of 15 minutes detention time at peak flow would be provided.

A flow schematic for the interim disinfection process is shown in Figure 11.2.1-3. A description of the operation is as follows: The wastewater is treated in the primary clarifiers (Batteries "A" through "D"). The treated wastewater is discharged into effluent conduits and is subsequently transferred to a 14 ft by 14 ft temporary conduit for conveyance to the interim disinfection basins. The wastewater would be disinfected as it travels through interim disinfection basins. The wastewater then exits the interim disinfection basins through three 10-ft-wide sluice gates and enters a 25 ft by 25 ft temporary effluent conduit for conveyance to the existing outfall.

When the new disinfection and outfall facilities are available for operation, the flow regime will be as follows. The wastewater will be treated in the primary clarifiers and transferred to the temporary conduit as described above. Within the temporary conduit, gates which were




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.2.1-3<br>DEER ISLAND<br>INTERIM DISINFECTION FLOW SCHEMATIC |
|---|---|

installed to connect to the temporary disinfection basins will be closed. Gates discharging to a new extension of the conduit will be open and flow will be conveyed to the new disinfection facility. The extension of the 14 ft x 14 ft temporary conduit is approximately 800 ft in length. The flow regime for this alternative is also shown in Figure 11.2.1-3.

Plant Water System

The existing plant water (non-potable) system provides screened primary effluent for various processes within the existing treatment plant. Current plant water uses include: fire hydrants, pump seals, heat exchangers on the Nordberg engines and the Enterprise engines, and chlorine feedwater. At present, the operation of the system is as follows: chlorinated plant effluent is screened and pumped at the Non-Potable Water Pumping Station and conveyed to a three million gallon reservoir and, subsequently, to needed sources. The primary use of the plant water in the reservoir includes the heat exchangers on the diesel engines at the North Main Pumping Station and the chlorination facilities. Plant water is also furnished to the chlorination facilities from a single 4000 gpm constant speed pump located at the midpoint of the effluent channel of the primary clarifiers. This pump is worn and presently operates at about 50 percent capacity.

Fast-track improvements to the plant water system include the installation of four constant speed pumps rated at 2800 gpm each and new traveling screens and strainers. Also included among the operational modifications to the plant water system is the installation of a closed loop cooling water system at the North Main Pumping Station, with potable water as the primary source of make-up water. The non-potable water system would be used as back-up to the closed loop cooling water system.

An analysis of plant water demands was done as part of this facilities plan to determine the future need for the reservoir. The reservoir's location on top of the drumlin necessitate its removal during early site preparation. The recommended construction schedule requires demolition of the reservoir no later than 1989. Data on plant water needs was gathered for two primary users of this water, the North Main Pumping Station and the disinfection facilities. From the evaluation of the data, it is estimated that for the years 1987-1990, the two facilities require a range of 7 to 20 mgd during average and peak demands. An additional 1 to 3 mgd was added to average and peak demands to account for miscellaneous facilities that use plant water. The total estimated plant water demand for the years 1987 to 1990 is 8 to 23 mgd. It is recommended that this demand be met by the continued use of the plant water system as back-up to the closed-loop cooling water system.

In the year 1993, the estimated peak demand is 35 mgd. This is the result of various modifications to the power facilities. In 1990, two 6000 kw generator sets and a 15 MW interim power source will be installed. These two sources will bring the peak demand to 25 mgd. In 1993, there will be two combustion turbines in operation generating on-site power. These additional two sources will bring the total peak demand in 1993 to 35 mgd.

To meet the plant water demand through 1993, it is necessary to modify the plant water system so that it can become the primary source of plant water. The required modification to the plant water system includes replacing the four 2800 gpm constant speed pumps with six 8000 gpm variable speed pumps. Six pumps are recommended to provide for redundancy, since four pumps will be capable of meeting the peak demand of 35 mgd. Further, a direct connection from the pumps to all needed plant water sources is required.

The peak plant water demand of the new treatment facility is 45 mgd. This system should be a closed-loop system and should be available for operation in 1998.

Power Facilities

The existing power generating capability at the treatment plant consists of five diesel generator sets provided by the Enterprise Engine and Machinery Company of Oakland, California. The engines for the system can be operated on digester gas or diesel fuel. The generators are rated at 700 kw each and were furnished by Allis Chalmers. Fast-track improvements to the diesel generators will meet the current needs of the treatment plant and will extend the useful life of the equipment through 1995. The fast-track improvements to the power facilities also include the installation of two 6000 kw dual-fuel diesel engine/generator sets. To construct the new facilities, additional power beyond that proposed under the Fast-Track Improvements Program is required. To meet this need, an immediate, but interim, power supply having a 15 MW capacity at 24 kv shall be available in January, 1990. The installation of this electrical service will increase the installed capacity to 30 MW and the secured capacity to 15 MW. The source of this power is Massachusetts Electric Company's Metcalf Square substation. It is expected that when the installation of the first permanent feeder is complete, the interim power supply will be removed from service.

By 1991, the power demand at the treatment plant is expected to increase. To meet this increase in demand, the first of two 115 kv feeder cables shall be installed. The source of power will be the 115 kv bus at the Boston Edison K Street substation. By the end of 1991, the peak essential load will equal 23,550 kw. In order to meet reliability requirements, reserve power capable of meeting this load is required. The installed capacity at that time will be the single feeder, and 15,500 kw of diesel generator capacity consisting of two 6000 kw generator sets and five 700 kw generator sets. The assumed loss of interim power will result in an essential peak power shortfall of 8050 kw. In order to satisfy the essential peak power demand, it is recommended that the combustion turbine portion of the combined cycle be operable by 1992. This turbine shall be rated at 22,100 kw and will be relied upon to provide continuous performance.

The second 115 kv feeder cable shall be in operation prior to 1995. Both feeder cables are to terminate in an MWRA-owned 115 kv ring bus with six circuit breakers. The other four line positions will be feeder positions to four 115 kv - 13.8 kv transformers, rated 30/40/50 m VA. Each of two transformers will feed a 13.8 kv switchgear bus via 15 kv, 3000A bus duct.

The onsite power generation would result from the addition of the stream cycle to the combustion turbine. This supply of power shall be available in 1993 and will consist of the following:

- Heat recovery steam generator
- Steam turbine and condenser
- Circulating water system
- Condensate system
- Deaerating feedwater heater
- Boiler feed system
- Make-up water treating system

Nut Island

The recommended site for the Nut Island headworks facility is where the existing anaerobic digesters stand. Construction of the headworks facility to meet the federal court schedule requires taking the digesters out of service earlier than other processes at the existing treatment plant. It is anticipated that the interim sludge management plan for Nut Island will provide a capacity to handle raw primary sludge before the end of 1991. This allows for taking the digesters out of service and enables the construction of the headworks facility to meet the court schedule.

Construction Sequence

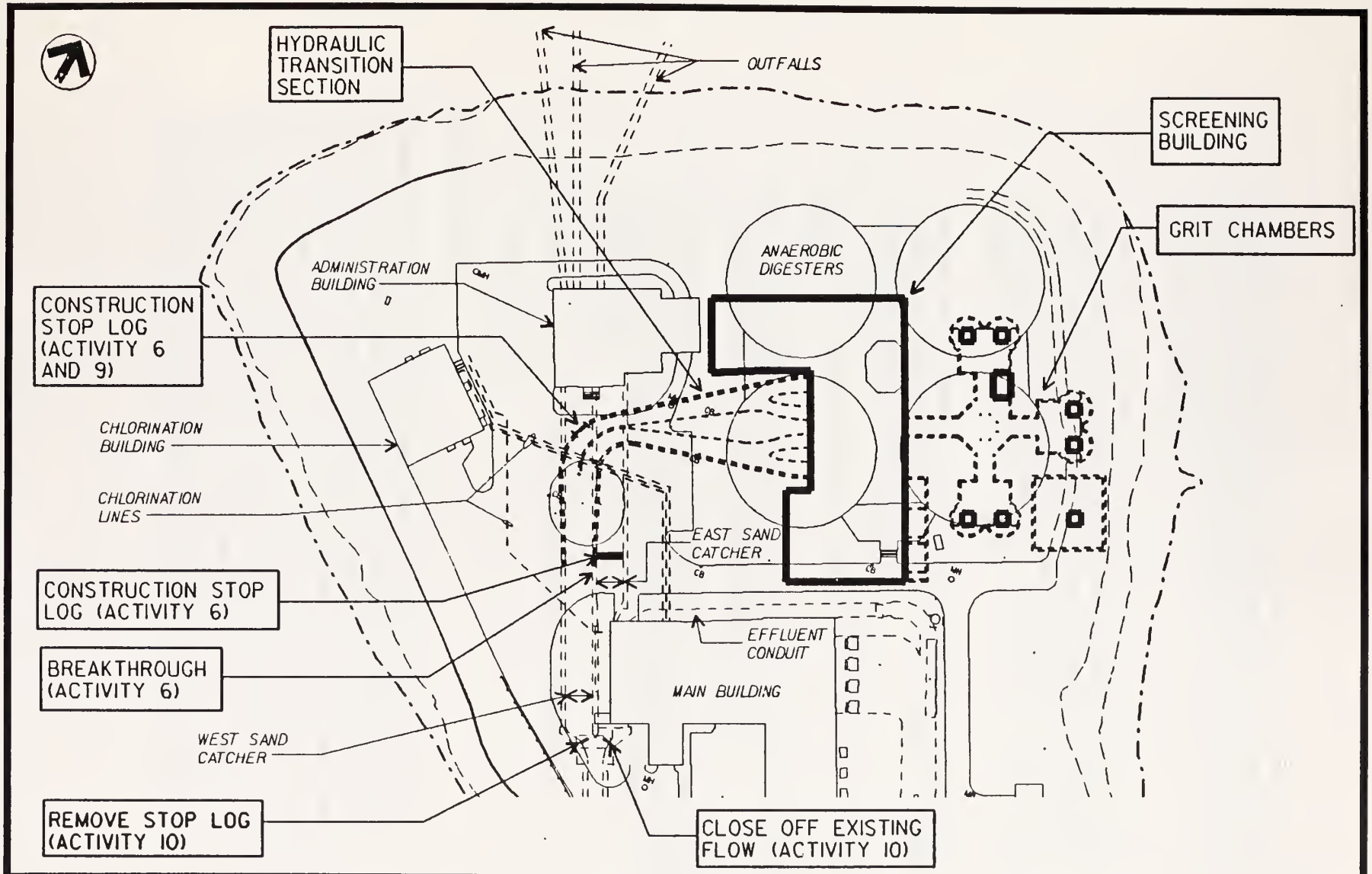
Construction of the new headworks facility must take place while maintaining operation of the existing treatment plant until the new inter-island conveyance tunnel, the new South System Pumping Station tunnel, and the Deer Island treatment facilities are available. In order to maintain continuous operation of the plant, sequencing of demolition and construction of temporary and new facilities is necessary. Figure 11.2.1-4 identifies the existing and new facilities at Nut island and where construction activities will take place. The sequence of construction activities is given below:

1. Relocate the section of 6-in-diameter water main that passes through the digester building. This water main supplies potable water to Nut Island.

2. Empty the four anaerobic digesters of sludge and digester gas, demolish the digesters, and remove the associated piping.

3. Construct the new headworks screening building and grit chambers.

4. Prior to construction of the new hydraulic transition section between the Administration Building and the Main Building, relocate the 4 chlorine disinfection lines (10 in. and 12 in. diameter) and other small diameter piping in that area.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.2.1-4**
**NUT ISLAND HEADWORKS FACILITY**
**CONSTRUCTION ACTIVITY**

5. Construct the headworks transition section between the new headworks facility and the easternmost sand catcher and within the west sand catcher. The east sand catcher presently takes treatment plant effluent to the outfalls while the west sand catcher is presently unused. The unused sand catcher will be rehabilitated. (This activity is concurrent with activity 3.)

6. By-pass effluent flow from the east sand catcher to the west sand catcher. This entails blocking off flow to the east sand catcher and breaking into the rehabilitated west sand catcher. Flow is directed to the outfalls through an opening constructed into the wall of the hydraulic transition section bend within the west sand catcher. The opening will be stop-logged when the new headworks are operating. (This activity is concurrent with activity 3.)

7. Complete the new hydraulic transition section by constructing the portion of the transition section that is in the east sand catcher. After this activity is completed the headworks facility is ready to accept flow.

8. Connect the headworks to the inter-island conduit and begin operation of the headworks facility.

9. Divert the treatment plant effluent from the west sand catcher through the headworks facility by using the construction stop-log described in activity 6.

10. Divert flow from the High Level Sewer through the new hydraulic transition section. The diversion would be accomplished by removing the existing stop log at the upstream end of the west sand catcher and closing off flow to the existing treatment plant headworks facility.

11. Decommission and demolish the existing wastewater treatment plant.

12. Landscape Nut Island.

Construction Schedule

Scheduling of construction of the Nut Island headworks facility must adhere to the federal court schedule that requires that the Nut Island headworks facility be fully operational by July, 1995. The court schedule also states that the existing Nut Island treatment plant must be decommissioned within six months of startup of the headworks. The estimated construction time for the headworks facility is 24 months. In order to have a fully operational headworks facility meet the court schedule, construction should be completed by December, 1994. This date sets January 1993 as the construction start date. The sludge and digester gas should be removed from the digesters as soon as the interim residuals facilities begin accepting raw primary sludge. By emptying the digesters as early as possible, demolition of the digesters, and therefore the whole construction schedule, will be allowed to proceed as planned.

Implementation of the Interim Residuals Program, scheduled to be completed by December, 1991, should not conflict with the start of construction of the headworks facilities unless there is a delay. However, if the interim residuals program is not implemented before January 1993, delays in construction of the headworks facilities may ocur.

### 11.2.2 CONSTRUCTION SCHEDULING

The Summary Project Schedule shown in Figure 11.2.2-1 displays the major project tasks and key milestone events critical to be project's completion in accordance with the intermediate and final target schedule dates set forth by the MWRA's court-imposed clean-up schedule for Boston Harbor. These tasks include, but are not limited to: facility planning reports; major design packages; and preliminary construction packages.

The summary schedule is based upon a Preliminary Master Construction Schedule which was developed using a computerized critical path method (CPM) program to account for the project's complexity in terms of limited site availability, the large quantities of excavated materials, the need for the water transport of vast numbers of equipment, personnel, and materials, and the court-imposed target dates which require full flow secondary treatment operations by the end of 1999. The master schedule, which is further detailed in Volume VII, presents the logical, time-phased sequence of individual construction activities within each of the following construction packages:

- Site Preparation I, 1988-1991

  -Early Site Preparation, 1988-1990
  -Completion of Site Preparation I, 1990-1991

- Power and Electrical Facilities, 1988-1995

  -Immediate Power, 1988-1990
  -Long Term/Permanent Power, 1988-1995

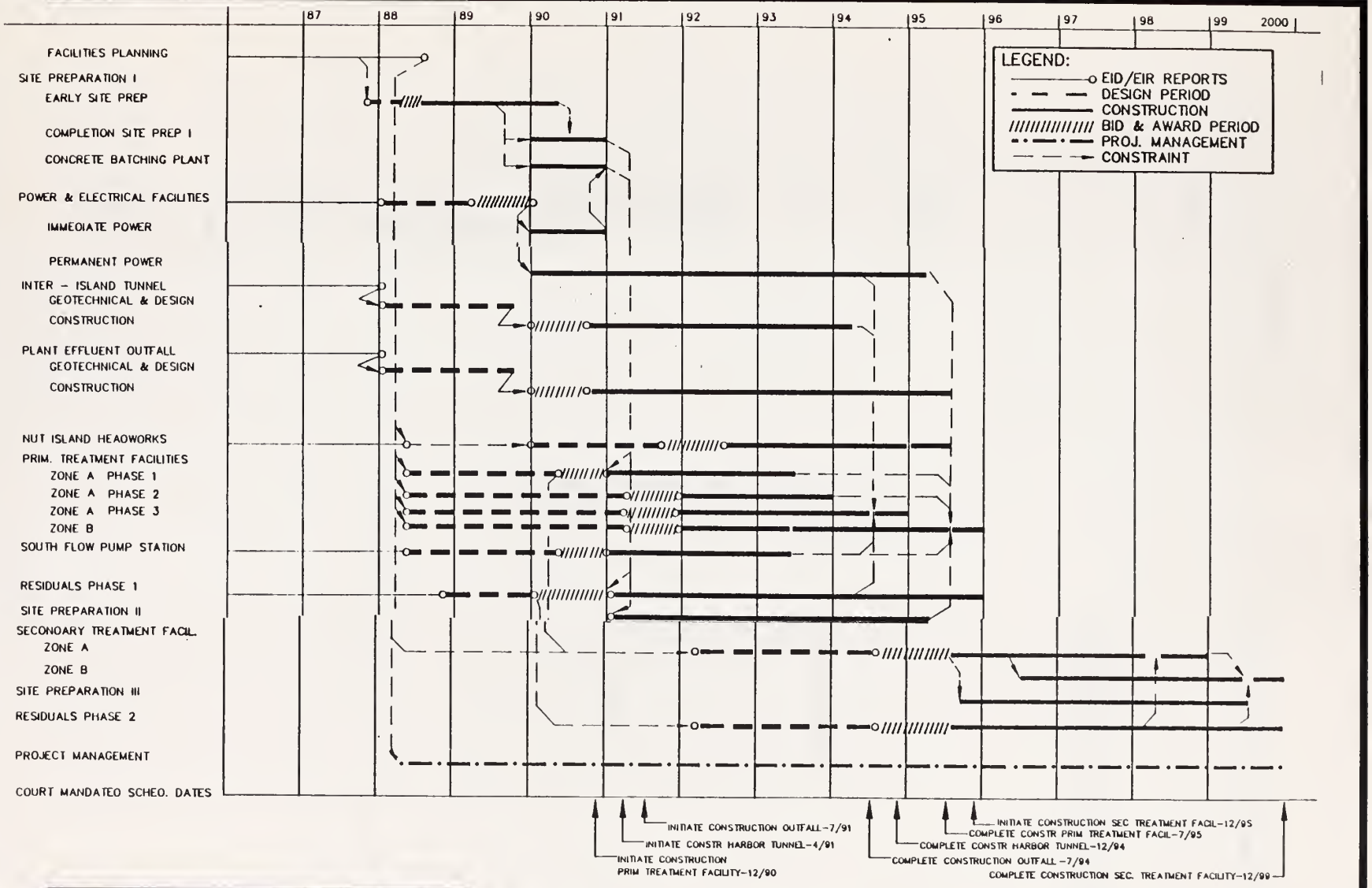
- Nut Island Headworks, Inter-Island Wastewater Conveyance Tunnel, and South System Pumping Station, 1990-1994

- Effluent Outfall, 1990-1995

- Primary Treatment Facilities

  Zone A, Phase 1 - 1991-1993

  - Main Pump Station and Winthrop Terminal modifications
  - North System Force Main
  - Grit facilities
  - Control building




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.2-1**
**SUMMARY OF PROJECT CONSTRUCTION SCHEDULE**

- Odor facility
- Administration building - existing pump station modification and addition

Zone A, Phase 2 - 1991 - 1993

- Primary Clarifiers Batteries A and B
- Temporary disinfection facilities, Selector A and B
- Temporary primary conduit connecting Selector A and B to the existing outfall
- Primary splitter box
- Secondary splitter box
- Primary screening facilities
- Primary sludge and scum pumping galleries

Zone B, Phase 3 - 1992 - 1994

- Primary clarifiers batteries C and D
- Selector C and D
- Temporary conduit from Selector Zone B to existing outfall
- Primary sludge and scum pumping galleries
- Maintenance building

o Residuals Phase 1, 1991-1995

o Site Preparation II, 1992-1995

o Secondary Treatment Facilities, Zone A and Zone B, 1995-1999

Zone A, 1995 - 1998

- Secondary clarifier batteries A and B
- Aeration basin batteries A and B
- Secondary conduits
- Disinfection basin
- Cryogenic generators
- Secondary sludge pumping station

Zone B, 1996 - 1999

- Secondary clarifier batteries C and D
- Aeration basin batteries C and D
- Secondary conduits
- Secondary sludge pumping system

o Residuals Phase 2, 1995-1999
o Site Preparation III, 1996 - 1999

In order to make it possible that each construction package can be completed within the dates shown on the CPM schedule, all critical task activities were first identified and the CPM schedule checked for delay restraints created by built-in constraints (e.g. removal of the Hill Prison by 1989). Assumptions regarding the proposed construction work schedules (e.g. treatment plant construction will occur during an eight (8) to sixteen (16) hour day occuring over two (2) shifts, five (5) days per week) were then entered into the CPM schedule to identify constraints affecting critical path activities. The preliminary master schedule also reflects the anticipated permitting, agency review, design, bid and award periods for each construction package.

Some of the critical path activities identified are:

Grit and Screening Reburial - The first major task to be done in early site preparation is the removal of existing grit and screenings at the south emd of the existing central drumlin and their reburial in a landform to be constructed at the southern tip of the island. This work restrains the start of the excavation of the central drumlin which is needed to prepare a level platform at elevation 125 ft for the construction of the new primary treatment facilities. Any delay in the grit and screenings removal and reburial will delay the project.

Demolition and removal of the Hill Prison - It is most important that the prison facilities be decommissioned, demolished and removed no later than December 1989. Should the prison be removed after December 1989, the scheduled construction of the landform in the prison area will be delayed and the excavated materials needed to construct the landform in the prison area may have to be stockpiled elsewhere, requiring two or more additional handlings of the material to complete the landforms. In addition to the delay, the increased handling of the excavated materials will also increase the noise impact on the neighboring Winthrop community and prison population. The need for off-island disposal of excavated materials would also increase; this would defeat the objective of keeping all excavated materials on-island during the early site preparation period, 1989-1990.

Geotechnical Information Needed for Tunnel Design - The construction of the effluent outfall tunnel scheduled in 1990-1995 is the most critical task (in terms of the schedule) to be accomplished within the court-imposed scheduled dates. The geotechnical information needed to establish the final design parameters for the outfall tunnel as well as the inter-island tunnel must be gathered and documented prior to the beginning of the preliminary design phase of each tunnel. The schedule requires the bidding of the geotechnical information thirty-three (33) months prior to the start of the outfall tunnel construction in August 1990. The construction of the tunnels will occur on a 24 hours per day, six days per week basis.

Power Facilities - In order to provide the required power for operation of the concrete batching plant and tunnel boring equipment, immediate power will be supplied to the plant

by December 1990. This temporary power supply will be provided through Massachusetts Electric Company (MECo) from its Metcalf Square Substation in Winthrop and supply 15 MW of power to site.

By January 1992, it is recommended that a 115 kv permanant feeder from Boston Edison's K Street Substation be installed. This supply will be sufficient to meet the power requirements for the operation of the first stage of the primary treatment facilities. A second 115 kv permanent feeder from BECo's Chesea substation, as well as an on-island 25,700 kw combined cycle power plant, will be installed by January 1995, providing sufficient power to meet the plant's design year power requirements.

Any delays in the scheduled installation of the power facilities could result in overall project delays.

## 11.3 COST ESTIMATES

### 11.3.1 CAPITAL COST

The estimated project cost for the recommended treatment facilities is approximately $1.325 billion dollars. These costs include the inter-island transport system from Nut Island to Deer Island, the South System Pumping Station, and site work including the work performed under early site preparation. The costs do not include the effluent outfall and residuals handling facilities. The outfall costs will be included once the site location is selected. The breakdown of the project cost is as follows:

| | Cost in Millions |
|---|---|
| Nut Island Headworks and Site Restoration | $38 |
| Inter-Island Transport System | 84 |
| South System Pumping Station | 40 |
| North Main Pumping Station, Winthrop Terminal and North Grit Removal | 71 |
| Primary Treatment Facilities | 241 |
| Secondary Treatment Facilities | 551 |
| Disinfection Facilities | 22 |
| Power Generation and Distribution | 103 |
| Site Work | 109 |
| Potable and Plant Water | 19 |
| Administration, Maintenance and Control Buildings | 47 |
| TOTAL | $1.325 |

The costs are based on September 1987 prices (ENR cost index of 4440) and include capital construction costs plus an allowance of 35% for engineering and contingencies.

The estimated costs are for a complete operational facility and include excavation, backfilling, structures, equipment, roads, inter-process flow conduits, and sitework. The sitework costs include normal sitework and the work being performed as part of the early site preparation phase described in Volume VI of the Facilities Plan. The construction of a concrete batching plant on the island is included in the early site preparation work. Operation costs of the batching plant are included in the concrete material costs. The costs of structures and equipment include materials, installation, and the additional handling required to transport materials to Deer Island from Quincy by barge. Also accounted for are the unique construction requirements of transporting construction workers to Deer Island by water, of constructing a project of this magnitude, and of working on the tightly constrained site.

### 11.3.2 OPERATION AND MAINTENANCE COST

Estimated operation and maintenance costs for the recommended treatment facilities, including the four remote headworks is $32 million dollars. A breakdown of this cost is shown in Table 11.3.2-1. These costs have been segregated into four categories: salary and wages; power; equipment maintenance; and chemicals. Salary and wages are based on an average cost, including fringe benefits, of $30,000 per year per employee. Power costs have been based on $0.036 per kwh. Equipment maintenance costs were based on discussions with the manufacturers of the required equipment, data from existing plant operations and previous experience. The chemicals required for air emission control and disinfection have been estimated based on current chemical costs.

The annual estimated operating costs for 1995, when only the primary treatment facilities are on-line, are $23 million dollars.

Cash flow projections and an overall financial plan for the construction and operation of the recommended facilities are discussed in Volume VII of this Facilities Plan which is entitled "Institutional Considerations." The implications of the capital, and operation and maintenance costs, escalated from September 1987 cost levels to projected construction and startup dates, are presented as part of the financial analysis contained in Volume VII.

## TABLE 11.3.2-1

## SUMMARY OF DESIGN YEAR OPERATION AND MAINTENANCE COSTS ($1,000)

| | Salary & Wages | Power | Equipment Maintenance | Chemicals | Total |
|---|---|---|---|---|---|
| Nut Island Headworks | 780 | 83 | 32 | 102 | 895 |
| North System Headworks | 2,190 | 88 | 120 | -- | 2,398 |
| Main Pumping Station, South System Pumping Station Winthrop Terminal and North Grit Facilities | 2,550 | 3,384 | 287 | -- | 6,221 |
| Primary Treatment | 1,830 | 2,277 | 213 | -- | 4,320 |
| Secondary Treatment | 2,400 | 4,391 | 558 | -- | 7,349 |
| Disinfection | 510 | -- | 14 | 2,180 | 2,704 |
| Air Emission Control | 240 | 235 | 300 | 4,578 | 5,455 |
| Power | 1,170 | -- | 1,496 | -- | 2,666 |
| TOTAL | 11,670 | 10,458 | 3,020 | 6,860 | $32,008 |

## 11.4 ENVIRONMENTAL IMPACT ASSESSMENT

The following section provides an assessment of the environmental impacts associated with the construction and operation of the recommended secondary treatment facilities described. This assessment covers the range of environmental issues associated with the development of wastewater treatment facilities on Deer Island and headworks facilities on Nut Island. Environmental impacts associated with the discharge of secondary-treated effluent are addressed in Volume V of the Secondary Treatment Facilities Plan.

Figures 11.1.2-1 and 11.1.3-2 provide site plans for Nut Island and Deer Island, respectively. The major site plan features for the recommended plan, which are addressed herein for Deer Island, include:

- Overall site development including development of landforms;
- Preliminary treatment for North System influent;
- Covered, stacked primary treatment clarifiers;
- Oxygen activated sludge secondary treatment, using stacked secondary clarifiers and anaerobic selectors;
- Disinfection using purchased sodium hypochlorite;
- Onsite power generating and switchyard facilities;
- Administrative, laboratory, operations and maintenance facilities.

For Nut Island, the new headwords facility and the creation of open space are the major elements addressed for the recommended plan.

### 11.4.1 GROUNDWATER

As described in Section 5.2.2, groundwater levels on Deer Island generally vary between elevations 108 to 114 ft, approximately 8 to 11 ft below the existing ground surface. Removal of the existing central drumlin and its subsequent use in recontouring Deer Island will result in a base construction grade of approximately 120-125 ft. Since all construction activities will be well above groundwater, and no future use of groundwater is proposed for the new facilities, no impacts to this resource are expected.

The Early Site Preparation activities described in Volume VI of these facilities planning documents provide for removal of approximately 85,000 $yd^3$ of grit and screenings which have been disposed of on Deer Island in locations south of the central drumlin. These wastes will be deposited in a secure landfill which will comprise the southernmost landform shown on Figure

11.1.3-2. The landfill design will comply with the DWPC criteria for "sludge-only" landfills. The use of a double liner and leachate collection provides permanent protection for the groundwater resource.

## 11.4.2 AIR QUALITY

This section summarizes an assessment of the potential air quality impacts associated with the operation of power and heat-generating equipment for the Deer Island wastewater treatment plant. The assessment has been performed for various project phases relative to current operations in order to make a comparison with air quality standards. An assessment of odor, VOC, and toxic compound impacts from wastewater treatment facility emissions is presented in Section 10.6.

The first step in this air quality analysis consisted of characterizing pollutant emissions and resultant air quality impacts associated with the existing equipment which consists of eight 1,500-kw Nordberg diesel engines and five 700-kw Enterprise diesel generators operated as required to meet power demand, as well as four heating boilers. The pollutant emissions and air quality impacts associated with the addition of two 6,000-kw engines (Fast-Track Improvements in 1988) were then examined and compared with the emissions and impacts associated with existing operations on Deer Island. Finally, the pollutant emissions and associated impacts for added on-site capacity via the recommended gas turbines were assessed in relation to the current air quality impacts and applicable standards.

This preliminary air quality impact analysis was performed using EPA screening-level computer models along with estimates of pollutant emissions obtained from EPA publications and equipment vendor data. Refined modeling, using five years of meteorological data, will be performed following DEQE's approval of the modeling protocol, and DEQE's issuance of baseline emission rates that are representative of the current facility operation. The results of this refined evaluation wil be included in the final Facility Planning documents.

Information on stack parameters needed for computer modeling was obtained from DEQE fuel-burning equipment registration forms (Form AP-1, DEQE 85) and from vendor-supplied data. Certain stack parameters, such as exit velocity, have been estimated using fuel use or heat-input data. In addition, estimates of background concentrations of the criteria pollutants on Deer Island were obtained from monitoring data published by the DEQE. The details of the analysis are included in Appendix H.

### Summary of Pertinent Regulations

The applicable ambient air quality standards for the Commonwealth of Massachusetts are the same as the National Ambient Air Quality Standards (NAAQS) and are shown in Table 5.2.4-1 in Section 5 of this volume. According to the Massachusetts Air Pollution Control Regulations (310 CMR 7.02), fossil fuel utilization facilities that have energy-input capacities greater than 3 million Btu/hour require approval by the Department of Environmental Quality Engineering (DEQE). This approval is based in part on the condition that emissions from the facility would not result in any violations of NAAQS. In addition, the DEQE has established a 1-hour $NO_2$

guideline of 320 ug/$m^3$ applicable to new or modified major sources of $NO_x$. DEQE policy states that any new source or modification of an existing source that will result in increased emissions of 250 tons or more per year must show that it will not cause more than one exceedance per year of the 320 ug/$m^3$ guideline at any location, with consideration of background levels. In addition, a new or modified major source of $NO_x$ must not increase hourly $NO_2$ concentrations by more than 32 ug/$m^3$ on more than one day per year when ambient hourly $NO_2$ concentrations in excess of 320 ug/$m^3$ are predicted to occur.

For a modification to a facility located in a nonattainment area (ambient pollutant concentrations exceed NAAQS) resulting in a significant increase in emissions of the pollutant in nonattainment, the project must comply with the provisions of 310 CMR 7.00, Appendix A (1)-(6), Emissions Offsets and Nonattainment Review. Since carbon monoxide (CO) and ozone are the only pollutants in nonattainment in Boston, an increase in CO emissions of 100 tons/year or more, or an increase in emissions of volatile organic compounds (VOC) of 40 tons/year or more, requires compliance with 310 CMR 7.00, Appendix A (1)-(6).

Along with the state regulations, the federally-mandated Prevention of Significant Deterioration (PSD) requirements may also apply, depending on the level of annual increases of the emitted pollutants. Increases in pollutant emissions are determined relative to a baseline emission rate established by DEQE to be representative of the current facility operation. If these increases in pollutant emissions are significant as defined in 40 CFR 51.24 (see Appendix H, Table H-20) increases in pollutant concentrations over the baseline concentrations are limited to the available portion of the ambient air increments.

In regard to emissions limitations, Massachusetts has adopted the federal New Source Performance Standards (NSPS). NSPS are applicable to the gas turbines, which must approximate $NO_x$ emission concentrations of 75 ppm for heat input rates greater than 100 million Btu/hr and 150 ppm for heat-input rates between 10 and 100 million Btu/hr. There is also a sulfur dioxide ($SO_2$) NSPS of 0.015 percent by volume for gas turbines, and the fuel cannot contain greater than 0.8 percent sulfur by weight. In addition, Massachusetts requires the use of Best Available Control Technology (BACT) for any facility modification resulting in changes in pollutant emissions. BACT is defined as an emission limitation based on the maximum degree of reduction for each applicable pollutant that the reviewing authority determines is achievable on a case-by-case basis, taking into account energy, environmental, and economic impacts.

Emissions Characteristics

The emissions characteristics needed to model the air quality impact of each piece of equipment include stack height, inside stack diameter, exit velocity, exit temperature, and pollutant emission rate. The values of the stack parameters and how they were obtained for each piece of power generation equipment are described in Appendix H. With the exception of the 6,000-kw Delaval diesel generators, the emission rates of the criteria pollutants from all equipment, including nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), carbon monoxide (CO), volatile organic compounds (VOC), and total suspended particulates (TSP), are estimated using EPA publication AP-42 (EPA, 1977). Vendor-supplied information has been used for the 6,000 kw Delaval diesel generators. The emissions estimates for the diesels assumed no flue-gas controls, while the

gas-turbine emissions assumed the use of water injection to reduce $NO_x$ emissions to 75 ppm by volume while burning distillate that meets NSPS and is guaranteed by the manufacturer. The $SO_2$ emissions from the gas turbines have been estimated to be less than 5 ppm by volume, which is well below the NSPS of 150 ppm. The diesel emissions of $SO_2$ assumed the use of 0.3 percent sulfur diesel fuel. The estimated pollutant emission rates from all equipment are given in Table 11.4.2-1.

These fuel-use assumptions provide conservative estimates of pollutant emissions for the project in terms of the full load and use of distillate fuel. Additionally, it was assumed that digester gas would not be available for use as a supplemental fuel. The use of digester gas in the diesels would reduce the estimated $SO_2$ emissions by approximately an order of magnitude and $NO_x$ emissions by about 25 percent. In estimating pollutant emission rates for modeling purposes, it was assumed that each piece of equipment operates at 100 percent capacity.

Table 11.4.2-2 lists the assumptions made for the types of existing and recommended future fossil-fueled equipment which would implement each of four phases of the power supply plan for Deer Island. Pollutant emissions rates for average and peak wastewater flows for each project phase are given in Table H-26 of Appendix H. The baseline emissions were based on actual fuel usage for 1985 from Form AP-1, DEQE 85. Table H-24 of Appendix H indicates that $NO_x$ emissions are estimated to increase for the 1988 and 1990 project phases, with startup of the new 6,000 kw diesel generators, and decrease for the 1995 phase, with the discontinuation of the Nordberg engines. The largest increase in $NO_x$ emissions was determined to occur in 1990 with an annual increase of 682 tons/yr. $SO_2$ emissions will increase for all project phases, with the largest increase of 78 tons/year occurring in 1990, but the final phase will see an increase of only 7 tons/year. The CO emissions will increase for all project phases except the 1988 phase. The largest increase will occur in 1990 at 21 tons/year. The 1995 increase will be only 5 tons/year. TSP emissions will increase very slightly in the 1988 and 1990 project phases (3 tons/year) but will increase by 50 tons/year in 1995. Likewise, the largest VOC emissions increase (40 tons/year) will occur in 1995.

Background Air Quality

Background air quality concentrations are determined from the air quality monitoring data published by the Massachusetts DEQE (DEQE, 1985). Wherever possible, data from the Deer Island monitoring station was used to determine background concentrations. For averaging times less than annual average, the highest monitored value from the latest three years of data was chosen as background. The largest annual average value for the three most recent years of data was also chosen as background. If data from Deer Island were not available for a given pollutant, the highest monitored values from nearby stations (Long Island, East Boston, Chelsea) for the three most recent years of data were chosen. The background concentrations selected for this analysis are described in detail in Appendix H.

**TABLE 11.4.2-1**

**POLLUTANT EMISSION RATES FOR ALL EQUIPMENT**

| | Pollutant Emission Rate (lbs/hr) | | | | |
|---|---|---|---|---|---|
| Equipment | NOx | $SO_2$ | CO | TSP | VOC |
| Nordberg diesel engine | 60.0 | 5.4 | 15.6 | (a) | 1.6 |
| Enterprise diesel generator | 30.0 | 2.7 | 7.8 | (a) | 0.8 |
| Delaval diesel generator | 171.4 | 19.1 | 9.1 | 0.6 | 0.4 |
| Cleaver Brooks heating boilers | 4.7 | 4.0 | 0.4 | 0.6 | 0.02 |
| Gas turbine (22 MW) | 99 | 10.5 | 45.8 | 14.9 | 16.6 |

(a) AP42 emission factors not available for TSP.

Table 11.4.2-2

DEER ISLAND FOSSIL-FUELED EQUIPMENT INVENTORY

| | NORDBERG DIESELS | | | ENTERPRISE DIESELS | | | DELAVAL DIESELS | | | COMBINED CYCLE (A) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | Oper.(b) (No.) | Stdby.(c) (No.) | ALF(d) (%) | Oper. (No.) | Stdby. (No.) | ALF (%) | Oper. (No.) | Stdby. (No.) | ALF (%) | Oper. (No.) | Stdby. (No.) | ALF (%) |
| Baseline | 4 | 4 | - | 2 | 3 | - | - | - | - | - | - | - |
| 1988-1989 | 1 | 7 | 2 | 4 | 1 | 2 | 1 | 1 | 100 | - | - | - |
| 1990-1994 | 1 | 7 | 2 | 4 | 1 | 100 | 1 | 1 | 100 | - | - | - |
| 1995-2020 | - | - | - | - | - | - | 1 | 1 | 30 | 1 | 1 | 75 |
| Boilers (all periods) | 3 | 1 | 41.7 | | | | | | | | | |

(a) Alternative 2 only
(b) "Operating"
(c) "Standby"
(d) "Annual Load Factor"

## Modeling

The air quality impacts of the fossil-fueled equipment for each phase of the project were estimated using the EPA Industrial Source Complex Short Term (ISCST) model in the screening mode for short-term impacts and the Industrial Source Complex Long-Term (ISCLT) model for annual average impacts (EPA, 1986). These computer models were executed for each piece of power generating equipment, assuming full-load operation, to obtain estimates of the maximum impacts of the individual equipment operation. The air quality impact of each project phase was then determined by summing the predicted concentrations to obtain the maximum impact for those combinations of equipment needed to supply the power demand for each project phase. Maximum predicted air quality impacts were determined for $NO_x$ (1-hour and annual average), $SO_2$ (3- and 24-hour and annual average), CO (1- and 8-hour) and TSP (24-hour and annual average). The 3-, 8-, and 24-hour concentrations were estimated from the 1-hour concentrations calculated by ISCST using the correction factors from the EPA "Guidelines for Air Quality Maintenance Planning and Analysis," Volume 10. More refined modeling using five years (1981-1985) of hour-by-hour meteorological data collected at Logan Airport will be performed following approval by DEQE of the modeling protocol and baseline emission rates. The details of the modeling analysis are described in Appendix H.

## Results and Conclusions

The air quality impacts of the power and pump stations for each phase including estimated background pollutant concentrations on Deer Island, are shown in Table 11.4.2-3. Changes in air quality impacts from the baseline to each project phase are shown in Table 11.4.2-4.

These tables indicate that the 1995 power-generating configuration would improve air quality in the area for all pollutants relative to existing emissions, with the exception of TSP, which would essentially stay the same for all periods. For the other time periods, Table 11.4.2-3 indicates that $SO_2$ concentrations would increase slightly; $NO_2$ concentrations would increase slightly, with the exception of the annual value in 1988; and CO concentrations would generally decrease. This analysis indicates that the project would meet ambient air quality standards with the possible exception in 1990 of the 1-hour $NO_2$ policy guideline. Since the 1990-1994 period is the only one in which $NO_x$ emissions increase more than 250 tons/year (see Table H-24 of Appendix H), the DEQE $NO_2$ policy of not exceeding 320 ug/$m^3$, including background, or not increasing the hourly impact by more than 32 ug/$m^3$ would apply. Since Table 11.4.2-4 indicates an increase of 46 ug/$m^3$ in the hourly $NO_2$ concentration from the baseline to 1990, a potential for a violation of this policy exists. A final determination on the baseline emissions, along with the refined modeling analysis, will be performed for the secondary facilities project following approval by DEQE of the modeling protocol and DEQE's issuance of a baseline emission rate representative of current operation.

The reason for the improvements in air quality resulting from the added generating capacity is that the new equipment is capable of generating much more power with a smaller air quality

Table 11.4.2-3

AIR QUALITY IMPACTS OF PROJECT PHASES

| | Maximum pollutant concentrations ($Mg/m^3$)(a) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | | | $NO_2$ | | CO | | TSP | |
| Year | 3-hr | 24-hr | Ann. | 1-hr | Ann. | 1-hr | 8-hr | 24-hr | Ann. |
| Baseline | | | | | | | | | |
| Predicted | 137 | 61 | 3 | 1,259 | 17 | 319 | 223 | 3 | 0.1 |
| Background | 367 | 254 | 34 | 304 | 61 | 29,000 | 10,000 | 130 | 54 |
| Total | 504 | 315 | 37 | 1,563 | 78 | 29,319 | 10,223 | 133 | 54 |
| Standard | 1,300 | 365 | 80 | 320 | 100 | 40,000 | 10,000 | 260 | 75 |
| PSD increment (a) | 512 | 91 | 20 | -- | -- | -- | -- | 37 | 19 |
| 1988-1989 | | | | | | | | | |
| Predicted | 154 | 68 | 2 | 1,305 | 10 | 262 | 184 | 4 | 0.1 |
| Background | 367 | 254 | 34 | 304 | 61 | 29,000 | 10,000 | 130 | 54 |
| Total | 521 | 322 | 36 | 1,609 | 71 | 29,262 | 10,184 | 134 | 54 |
| Standard | 1,300 | 365 | 80 | 320 | 100 | 40,000 | 10,000 | 260 | 75 |
| PSD increment (a) | 512 | 91 | 20 | -- | -- | -- | -- | 37 | 19 |
| 1990-1994 | | | | | | | | | |
| Predicted | 154 | 68 | 4 | 1,305 | 31 | 262 | 184 | 4 | 0.1 |
| Background | 367 | 254 | 34 | 304 | 61 | 29,000 | 10,000 | 130 | 54 |
| Total | 521 | 322 | 38 | 1,609 | 92 | 29,262 | 10,184 | 134 | 54 |
| Standard | 1,300 | 365 | 80 | 320 | 100 | 40,000 | 10,000 | 260 | 75 |
| PSD increment (a) | 512 | 91 | 20 | -- | -- | -- | -- | 37 | 19 |

Table 11.4.2-3

## AIR QUALITY IMPACTS OF PROJECT PHASES
(Continued)

| Year | Maximum pollutant concentrations ($Mg/m^3$)(a) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | | | $NO_2$ | | CO | | TSP | |
| | 3-hr | 24-hr | Ann. | 1-hr | Ann. | 1-hr | 8-hr | 24-hr | Ann. |
| 1995-2020 | | | | | | | | | |
| Predicted | 84 | 37 | 1 | 468 | 3 | 37 | 26 | 5 | 0.1 |
| Background | 367 | 254 | 34 | 304 | 61 | 29,000 | 10,000 | 130 | 54 |
| Total | 451 | 291 | 35 | 772 | 64 | 29,037 | 10,026 | 135 | 54 |
| Standard | 1,300 | 365 | 80 | 320 | 100 | 40,000 | 10,000 | 260 | 75 |
| PSD increment (a) | 512 | 91 | 20 | -- | -- | -- | -- | 37 | 19 |

(a) Class II PSD increments

impact than the existing equipment (refer to Appendix H, Table H-26). For the 6,000-kw diesel generators, the smaller impact is related to lower pollutant-emission rates and the higher plume rise associated with the larger volumetric flow and higher exhaust temperature. The gas-turbine impacts are much smaller per kilowatt than the diesels, mainly because of the much smaller pollutant emission rates associated with the use of distillate and emission controls (water injection) as well as the greater stack height. Thus, replacing existing equipment with new generating equipment as much as possible results, for the most part, in improved air quality impacts.

In regard to the nonattainment issue for CO and ozone, it was stated previously that an increase in CO emissions of 100 tons/year or more or an increase in VOC emissions of 40 tons/year or more would require compliance with 310 CMR 7.00, Appendix A. Table H-24 of Appendix H indicates that the maximum increase in CO emissions is expected to be only 21 tons/year, well below the 100 tons/year limit. However, this table also indicates that the maximum increase in VOC emissions is expected to be approximately 40 tons/year in 1995. Therefore, the application of the requirements of 310 CMR 7.00, Appendix A, to VOC emissions for the 1995 project phase is in question until a better definition of the baseline is available.

In regard to the application of the PSD requirements to this project, $NO_x$, $SO_2$, and TSP emissions increases of 682, 78, and 50 tons per year, respectively, were estimated to occur in the 1990 to 1994 period (Table H-24 of Appendix H). Since these increases are larger than the "significant" increase definition given in Table 8.1-2 of Appendix H for these pollutants, compliance with PSD $SO_2$ and TSP increment consumption would apply to this phase of the project. However, as indicated in Table 11.4.2-4, the preliminary estimates of increases in $SO_2$ and TSP concentrations are very small compared to the Class II increments. Although the available portion of the increment is not known at this time, this analysis indicates that it would be unlikely that PSD increments would impose constraints on the project.

### 11.4.3 LAND USE AND VISUAL IMPACTS

#### Deer Island

#### Land Use

Construction and operation of the new wastewater treatment facility on Deer Island will change land use on those portions of the island currently used for activities other than wastewater treatment and will also affect the abutting community of Winthrop.

During construction, existing facilities will be demolished (with the exception of historic structures identified for preservation). In addition, earth moving and construction of the new facility will temporarily change the character of the island to a high-intensity construction area. Earth berms, constructed early in the site preparation phase of the project, will, however, serve as a separation zone between the construction activities and the adjacent Point Shirley community.

## TABLE 11.4.2-4

## CHANGES IN AIR QUALITY IMPACTS COMPARED TO EXISTING IMPACTS

Maximum predicted pollutant concentrations plus background ($ug/m^3$)

| | $NO_x$ | | $SO_2$ | | | CO | | TSP | |
|---|---|---|---|---|---|---|---|---|---|
| Year | 1hr | Annual | 3-hr | 24-hr | Annual | 1-hr | 8-hr | 24-hr | Annual |
| Baseline | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 46 | 7 | 17 | 7 | 1 | 57 | 39 | +1 | 0 |
| 1990 | 46 | 7 | 17 | 7 | +1 | 57 | 39 | +1 | 0 |
| 1995 | 791 | 14 | 53 | 24 | 2 | 282 | 197 | +2 | 0 |

Upon completion of construction activities in 1999, virtually the whole island will be dedicated to wastewater treatment. The exceptions will be a large separation zone area of open space on the neck of the island between the facility and Point Shirley, and an extension of this zone continuing along the eastern edge of the property to the southernmost point of the island. These areas will be open for public access and will provide new recreation opportunities including the possible construction of new bicycle trails or footpaths.

In addition to the direct effects of increased recreation opportunities on the island itself, the new facility will also improve the quality of water recreation at beaches throughout the area by contributing, with other on-going MWRA projects, to the cleanup of Boston Harbor.

Visual Impacts

While the construction of the new facility will change views from locations around the harbor, the change should generally be beneficial. As part of the site preparation and construction activities, landforms will be constructed around the northern, eastern and southern portions of the island to block views of the new facility from residential and recreation locations in the region. Distant views of the new facilities will be available from locations to the west; however, the berms will form a backdrop to the facilities which will soften the islands' profile and minimize the impact. Upon completion of the facility and landscaping, the island will appear more natural from most viewing locations than it does at present, and will provide a profile which will be in harmony with the other harbor islands.

The open space which will be accessible to the public at the northern end of the island will be separated from the facility by a landform and will, therefore, have only minimal views of the facility. While the bike path will have views of both the ocean and the wastewater treatment facility, its location and the attractiveness of the recreational opportunity it offers should make it a desirable addition to the area.

Nut Island

Land Use

The construction of the new headworks on Nut Island should significantly improve the compatibility of land use with abutting neighborhoods as well as provide a new area for high quality recreational opportunities. Upon completion of the facility, the island will be landscaped to provide a large area of open space between the abutting Quincy Great Hill neighborhood and the plant. In addition, consideration can be given to providing a bicycle trail or a footpath around the island which will provide access to the northwestern end.

Visual Impacts

During construction activities, Nut Island will take on the appearance of a construction site and will be visually incompatible with the abutting residential areas. This impact will, however, be temporary as the new appearance of the facility will be a significant improvement

over current conditions. Upon completion of the facility, the island will include a low landform, and landscaping and vegetation will replace the current surface of concrete and asphalt and soften the new facility's appearance. This new appearance will be more natural from abutting neighborhoods as well as from other viewing locations throughout the harbor.

### 11.4.4 TRAFFIC

Transportation requirements to Deer Island and Nut Island for construction of preliminary, primary, secondary, disinfection, and support facilities for the new treatment facilities include initial transport of construction equipment, periodic transport of materials to and from the island, and daily transport of workers to and from the site during all phases of construction. Traffic impacts at Winthrop, associated with these activities will be minimal. Appendix K details the analysis of traffic impacts during the construction of the treatment facilities.

During the approximate 8-year period of treatment facilities construction (1991 to 1999) after competition of piers, the estimated average daily requirements for construction workers following completion of pier facilities will range from 155 to 670 with a peak range of 205 to 875. Estimated average daily truck trip volumes relative to onshore pier locations will range from 20 to 110 with a peak range of 40 to 180. Roll-on/roll-off (RO/RO) truck trip volumes were determined by using a uniform shipment quantity of 22 $yd^3$ or 20 tons of material per truckload. All materials transport has been expressed in terms of truck shipment to provide a common basis for evaluating impacts. It is likely that most or all of the bulk materials required for facility construction, such as cement and aggregate, will be loaded onto barges at docking facilities close to supply sources for over-water transport to Deer Island and Nut Island. To determine the sensitivity of the traffic estimates to assumptions made on the point of origin of bulk materials, and the use of barges instead of roll-on/roll off trucking, an analysis was made assuming that one-half of the Portland cement, fine and coarse aggregate, would be transported by barge. This analysis indicated that the total truck transport estimate would be reduced by approximately 35 to 45 percent.

Peak worker needs will occur in 1992 and 1993 during primary treatment facilities construction, and in 1996 and 1997 during secondary treatment construction. Peak truck trip volumes will occur from 1992 through 1993 and from 1996 through 1997 and are directly related to facility construction schedule overlaps. Table 11.4.4-1 presents the estimated average and peak daily worker and truck volumes by year.

The minimal traffic impact during treatment facilities construction is a result of several abatement measures intended to alleviate the possibility of unmanageable traffic conditions on local roads in Winthrop. To alleviate the volume of construction worker vehicles on local roads, half of the workers will be transported to Deer Island via ferry from remote docking facilities, while the remainder will be bused to and from Deer Island using satellite parking facilities. The MWRA is committed to limiting the trucking volumes through Winthrop to Deer Island after pier construction to no more than eight small service trucks per day. The remainder of the equipment and materials deliveries will be made via barge to the new pier facilities. Since the overall levels of service are not expected to decrease with the addition

TABLE 11.4.4-1

ESTIMATED FACILITY AVERAGE AND PEAK
DAILY CONSTRUCTION WORKER AND TRUCK VOLUMES

| YEAR | WORKERS | | RO/RO TRUCKS | |
|---|---|---|---|---|
| | AVE | PEAK | AVE | PEAK |
| 1991 | 155 | 205 | 20 | 40 |
| 1992-1993 | 550 | 720 | 110 | 180 |
| 1994 | 310 | 405 | 65 | 95 |
| 1995 | 450 | 585 | 85 | 125 |
| 1996-1997 | 670 | 875 | 95 | 170 |
| 1998 | 320 | 415 | 50 | 90 |
| 1999 | 245 | 320 | 40 | 70 |

of construction vehicles during early site preparation, it can be expected that the addition of eight trucks per day to existing volumes will be negligible.

Following are descriptions of the satellite parking plan.

Satellite Parking Assessment

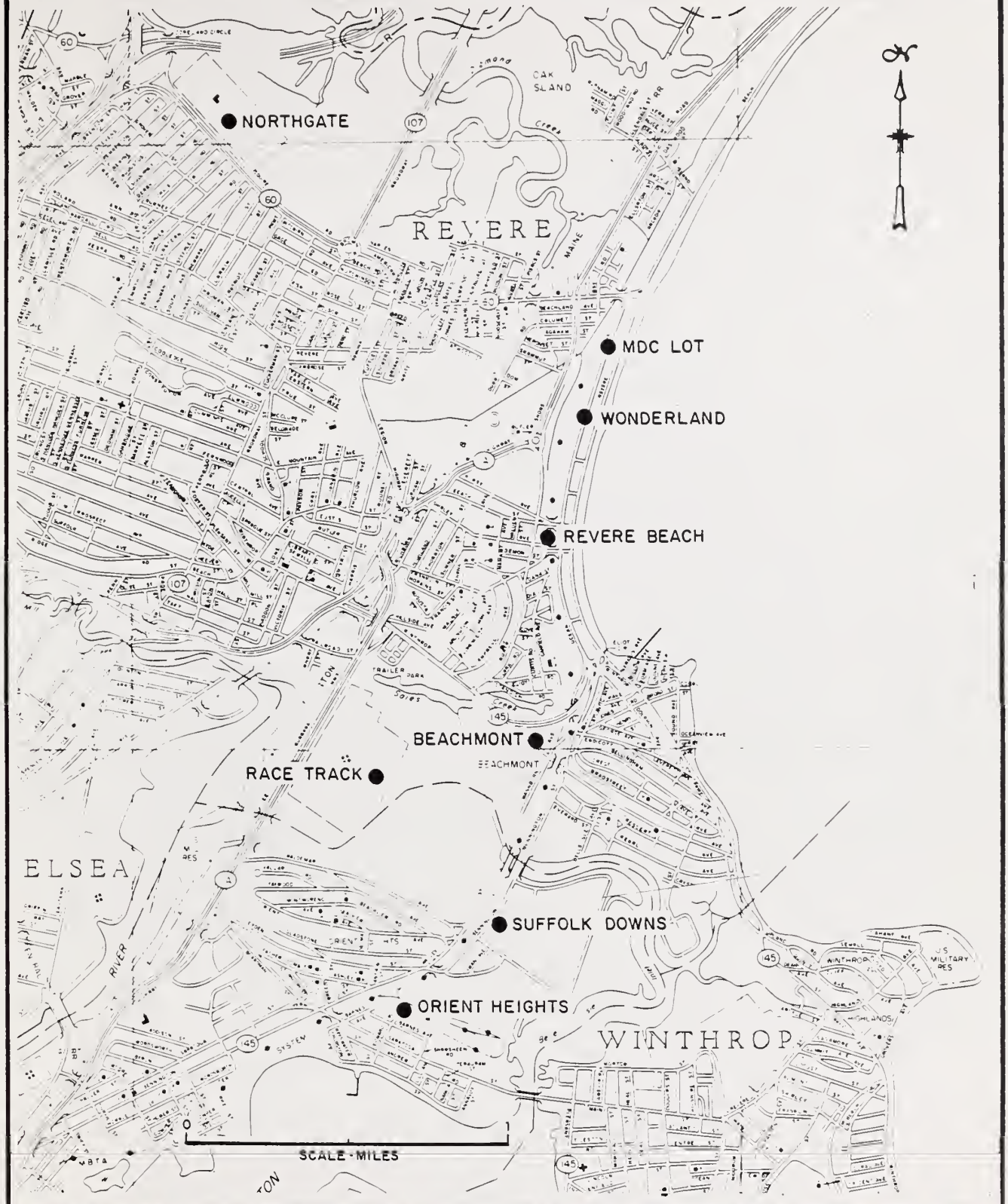
Due to the logistical constraints associated with the Deer Island Wastewater Treatment Plant, construction activities will present some unusual transportation problems. Deer Island is connected to the mainland by a causeway. The causeway is accessed by a network of local roads passing through the town of Winthrop. Earlier investigations have indicated that an arrangement allowing unrestricted access to Deer Island by automobile during construction activities would give rise to unacceptable traffic management problems in Winthrop. Therefore, construction workers seeking access by land will have to do so by traveling to satellite parking areas for transfer to the site by bus. Construction worker transport over water by ferry has been addressed in previous reports to MWRA and impacts associated with this operation will not be considered here. This analysis will address the overland transport of workers who cannot conveniently access the ferry landing locations and must access the site by land.

For the purpose of analysis and impact assessment, it has been assumed that as much as half of the total workforce required at Deer Island may seek access by land. For the most part, these workers will be coming to the site from the eastern, northern, and northwestern parts of the metropolitan Boston region.

Of the options available to employ the satellite parking facilities and subsequent busing to the site, the one which now appears most attractive would be to extend the operating authority of the bus company currently serving Winthrop to allow scheduled vehicles to service designated parking facilities along or near the MBTA Blue Line through East Boston and nearby communities. Operation of the buses serving the satellite parking areas could be performed during off-peak hours to further minimize any conflict with, for example, school bussing.

Parking for approximately one-half of the construction workforce could be accommodated by linking three satellite parking areas to Deer Island by bus. Appendix K of this report outlines the assessment method used to determine the available options for development and use of satellite parking facilities.

Eight sites were selected as candidates for the parking facilities based on location and present use and each was subjected to twelve general screening criteria. Figure 11.4.4-1 indicates the locations of these sites on a regional map. Table K-5 located in Appendix K presents the eight candidate sites and the general screening criteria in a site selection criteria matrix. These screening criteria and the five sites which were not selected are described in detail in Appendix K. The three facilities which best meet the general criteria are the Orient Heights Blue Line Station, the Suffolk Downs Race Track, and the Metropolitan District Commission (MDC) lot north of Wonderland. All of these sites are easily accessible through the existing road network and are close to Deer Island and to each other.




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.4.4-1**
**SATELLITE PARKING FACILITEIS**
**CANDIDATE SITES**

The Orient Heights MBTA Blue Line Station is located in East Boston and has parking facilities northeast of the intersection of Bennington and Saratoga Streets. These facilities currently serve Blue Line commuters and are filled to capacity each day. The lot can be improved to provide an additional 50 parking spaces. Most workers using the Blue Line to commute to satellite facilities would disembark at this location.

The Suffolk Downs Race Track is located south of Winthrop Avenue in Revere and can be reached from the Suffolk Downs and Beechmont MBTA Blue Line Stations. The race track has a capacity of approximately 3,000 parking spaces; at least one-fourth or 750 spaces could be available for Deer Island worker parking.

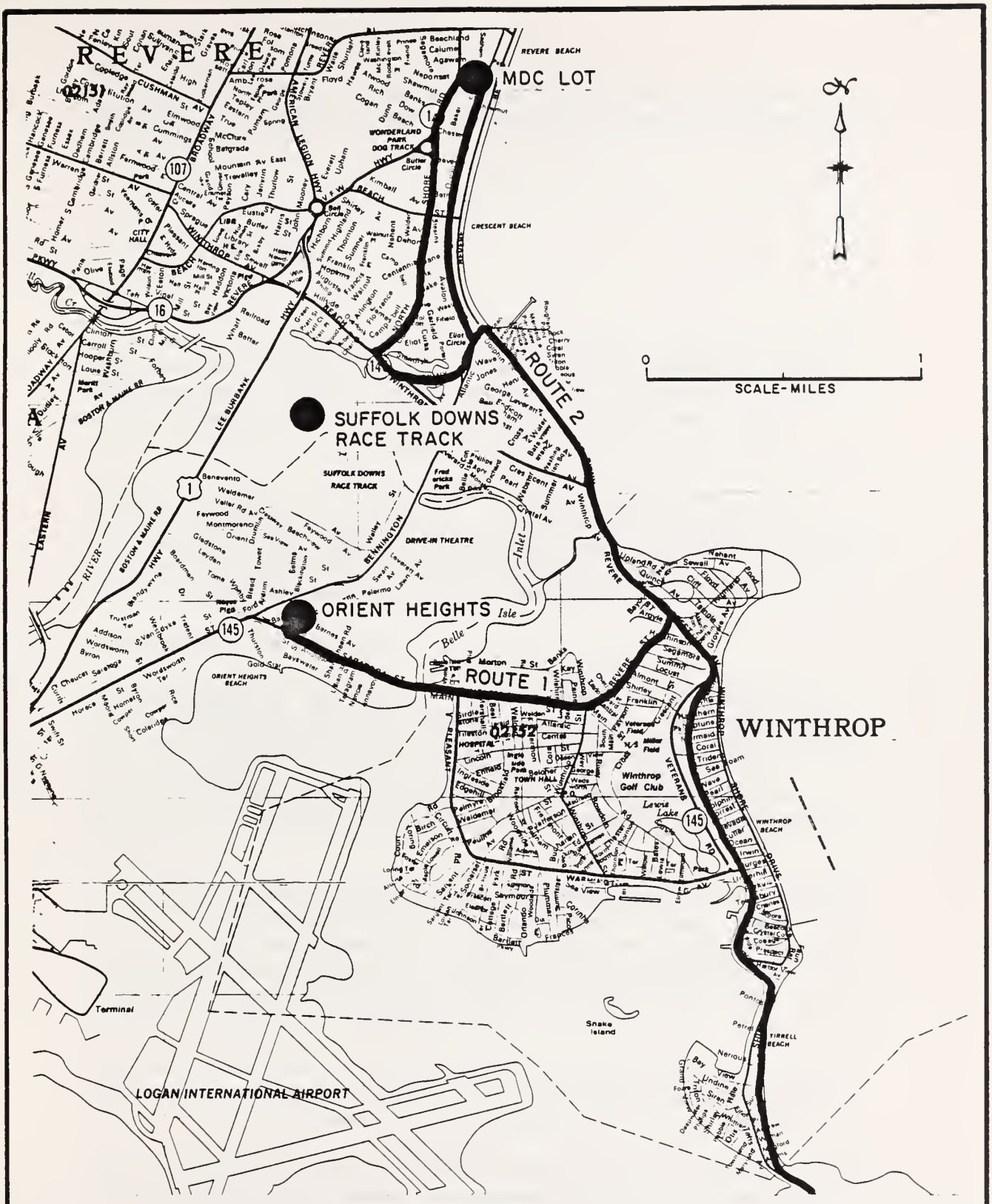
The Metropolitan District Commission parking lot is located on Ocean Avenue south of Revere Street and is just north of the eastern portion of the Wonderland MBTA parking facility which currently serves the Blue Line commuters. The MDC lot can be marked to hold approximately 800 parking spaces; one-half could be available for Deer Island worker vehicles without reducing the space currently used by commuters.

Each of the three recommended satellite parking areas is described in greater detail in Appendix K.

Satellite parking at these locations could provide a combined capacity of approximately 850 parking spaces for worker vehicles. All three sites are accessible by automobile and by public transit. It is anticipated that most workers will travel to the parking areas by automobile. Intersections in the vicinity of the three sites that could be affected by the additional construction worker automobile traffic have been identified. These intersections have been analyzed to determine existing levels of service and to ascertain whether the increased construction traffic would reduce these service levels. In all cases, service level remains unaffected by the traffic addition. The detailed intersection analysis can be found in Appendix K.

A bus service operating plan has been devised which would facilitate access among the parking sites and take advantage of the bus service that already exists in the area. Bus service to the three sites would occur along two routes with no more than one bus per stop at any one time. These routes are presented in Figure 11.4.4-2. Approximately three Route 1 buses and four Route 2 buses are needed in the peak periods. The service interval is 15 minutes and buses travel at an average speed of 15 mph. Route 1 cycle time is 45 minutes and Route 2 cycle time is 50 minutes including allowance time for bus stop worker transfer. One-way trip travel time between Deer Island and satellite areas would not exceed 30 minutes. Buses would be scheduled at intervals throughout the day with shorter intervals during the shift changes and longer intervals between shift changes. Appendix K describes the bus service operating plan in greater detail.

Finally, plant administration, operation and maintenance personnel could also use the satellite parking areas and proposed busing plan to access Deer Island. This will involve the transport




**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.4.4-2**
**SATELLITE PARKING FACILITIES**
**RECOMMENDED SITES**

of approximately 300 workers on a daily basis for the life of the treatment plant. Both Suffolk Downs Race Track and the MDC lot have space to accommodate plant personnel parking requirements.

## 11.4.5 NOISE

### Deer Island Operation Noise

#### Introduction

The new wastewater treatment facilities will include a large number of equipment items such as pumps, compressors, motor drives, a gas turbine, etc, which have the potential for creating audible off-site noise. This section describes an analysis which was performed to identify the significant potential contributors to off-site noise, estimate their sound levels in Point Shirley, and select the conceptual noise mitigation required to minimize noise impact.

The analysis demonstrates the technical feasibility of achieving a facility sound level which will have minimal impact on the Point Shirley area. It also indicates that there is a considerable amount of equipment which will need noise mitigation, and documents the degree of noise control required. Finally, it summarizes the noise control commitments so they can be incorporated into the final noise control engineering design of the facility.

#### Process Noise Prediction and Control

Source Characterization. Certain noise sources such as the gas turbine generator and large compressors are loud enough to be very audible off-site, without noise abatement. Numerous other sources are significant because of the cumulative effect of a large number of secondary sources. At this point in the facility's conceptual design, detailed information about building ventilation opening size and location, and make and model of equipment, is not available. Thus, sound levels typical of the equipment to be used were incorporated into the analysis.

The sound level predictions were made as follows. Nine major noise sources were identified on the plot plan, each representing a process or building of the facility, as listed in Table 11.4.5-1. A spread sheet was prepared for each source location which tabulated and summed the sound power levels of each contributing source at that location. Each spread sheet then calculated the total octave band sound pressure level and A-weighted sound level contribution of that source location for each community location.

The design goal of this analysis was to keep the expected plant sound level equal to, or less than, the existing nighttime residual ambient sound level of 39 dBA at Point Shirley (MWRA, 1986). These levels were adopted as the acoustical design goal for the operating facility.

Where noise mitigation was found to be required, it was incorporated into the predictions using proven noise abatement methodologies. The attenuation of silencers was, for instance, taken

from catalogues. The transmission loss of building materials was based on field data or laboratory test data.

While the final design of the facility may have minor differences from the conceptual design used in this report, the acoustical requirements have been set forth, and mitigation measures will be modified as necessary to accommodate any changes made during detailed design.

Community noise predictions of this complexity are sometimes made with computer programs which predict far field sound level contours based on the source sound power levels and locations. This approach has certain advantages in terms of ease of use, but in order to promote an open understanding of the methodologies used and to facilitate independent review of the predictions, these noise predictions have been made by computer using a spreadsheet format. All assumptions and distances used in the calculation are thus visible, and review and checking of the methodology is straightforward.

The following paragraphs discuss the methodologies used for the noise predictions. The sound power levels so derived are given in Table 11.4.5-2.

Compressors. Compressor intake and casing sound power levels were estimated with the methodology given in EEI, 1978. It was assumed for this analysis that the exhaust noise is controlled by the piping and insulation.

Pumps. Pump noise predictions were based upon Miller, 1981, p.7-10.

Motors. Motor noise was estimated based on motor horsepower, type of motor and need for noise control. Typical sound power levels for motors as rated by the National Electrical Manufacture's Association (NEMA) for motors of standard design were taken from Harris, 1979. However, where motors were used outdoors, quiet motors were usually used in the prediction.

Building Attenuation. It is assumed that the buildings are enclosed and that ventilation openings or fans are either of limited size and directed southward away from Point Shirley, are silenced, or both. This assumption is made because building ventilation design detail is not availble at this stage of plant design.

For the estimates, buildings were assumed to be lined with acoustically absorbent material. This reduces the reverberant interior sound level, minimizing occupational exposure to noise within the building, and lowers sound levels in the community. The calculation indicates that for most of the buildings this degree of silencing is not required to meet community criteria, and that when detailed engineering of the ventilation and interior acoustical treatment of the system is performed an additional 5 to 10 dB of noise emission may be allowed from some of the buildings. This extra noise allowance for a building can be used by either relaxing the requirement for full acoustic treatment for the interior, or by allowing unsilenced ventilation.

The need to employ proper acoustical design during the detailed design of building ventilation

## TABLE 11.4.5-1

## SUMMARY OF PRIMARY NOISE PRODUCING EQUIPMENT FOR THE DEER ISLAND TREATMENT FACILITY

| System | | Distance(1) | Noise Source |
|---|---|---|---|
| 1. | North Pumping Station (in)(2) | 2250 | 10 @ 3000 hp electric motor pump drives (with open roll door) existing pump station |
| | Power facility (ex) | | 2 @ 6000 kw diesel generators<br>25 mw gas turbine, cogeneration boiler<br>13.5 kva transformer |
| 2. | Winthrop (in) Terminal | 2480 | 4 @ 125 hp electric motor pump drives - air emissions<br>2 @ 390 hp electric motor pump drives |
| 3. | Stacked Secondary Clarifiers (in) | 2920 | 20 @ 300 hp RAS pumps (12 operational)<br>20 @ 7.5 hp WAS pumps (12 operational)<br>16 @ 40 hp scum pumps (8 operate)<br>144 @ .5 hp sludge collectors<br>202600 cfm blower 150 hp (1 operational) |
| 5. | Aeration (ex) | 3420 | 6 @ 150 hp mechanical aerator motors<br>18 @ 100 hp mechanical aerator |
| 7. | Aeration (ex) | 3780 | 6 @ 150 hp aerator drives<br>18 @ 100 hp aerator drives |
| 8. | Selector Basins | | 32 @ 20 hp mechanical mixers |
| 9. | Oxygen Production (in) | 4420 | 2 @ 3500 hp compressors casing, inlet and motor (1 operational)<br>(ex) 8 @ 50 hp purge blowers (tested once per week) oxygen production reversing valves<br>8 @ 40 hp scum pumps (40 peak) |

## TABLE 11.4.5-1

## SUMMARY OF PRIMARY NOISE PRODUCING EQUIPMENT FOR THE DEER ISLAND TREATMENT FACILITY (continued)

| System | | Distance(1) | Noise Source |
|---|---|---|---|
| 10. | Primary clarifiers (in) | 3700 | 40 @ 7.5 hp sludge pumps (24 operate)<br>63000 cfm blower for odor control<br>96 @ 0.5 hp sludge collection<br>2 @ 1600 cfm, 100 hp blowers for aerated channels (1 operational) |
| 11. | South Pumping Station (in) | 4200 | 4 @ 1250 hp electric motor pump station<br>32 @ 5 hp electric motor slurry pump drivers (21 operational)<br>blowers |
| 12. | Roll-on/rolloff pier (ex) | 3800 | 2 @ 40 hp motor pump drive (standard sound levels) |

(1) Distance (ft) to nearest neighbor, Point Shirley, Winthrop
(2) (in) means interior - source enclosed in building
(ex) means exterior - source outside

Table 11.4.5-2

## OCTAVE BAND SOUND POWER LEVELS FOR EACH MAJOR SOURCE LOCATION

| | Noise Source | 31 | 63 | 125 | 250 | 500 | 1K | 2K | 4K | 8K |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | North Pumping Station Power Facility | | 100 | 100 | 98 | 103 | 90 | 84 | 80 | 77 |
| 2. | Winthrop Terminal | | 98 | 97 | 93 | 76 | 66 | 55 | 51 | 49 |
| 3. | Stacked Second | | 102 | 98 | 94 | 87 | 81 | 72 | 68 | 63 |
| 5. | Aerators | | 83 | 87 | 89 | 88 | 84 | 78 | 74 | 72 |
| 7. | Aerators | | 83 | 87 | 89 | 88 | 84 | 78 | 74 | 72 |
| 9. | Oxygen Facility | | 103 | 99 | 94 | 91 | 85 | 96 | 79 | 87 |
| 10. | Primary Clarifiers | | 98 | 94 | 88 | 85 | 83 | 67 | 66 | 64 |
| 11. | South Pumping Station | | 98 | 96 | 91 | 89 | 83 | 67 | 66 | 64 |
| 12. | Roll-on-roll-off pier | | 94 | 96 | 98 | 98 | 100 | 96 | 92 | 87 |

systems is apparent, based on these evaluations. For instance, for a building one hundred feet square, the sound coming from an opening in the wall of one square yard facing the residential area would equal that coming through the walls of the balance of the building. If that opening were on the south side of the building, however, it could be perhaps 20 times larger before it would have the same impact as building noise. Also, if sound-absorbing material does not cover the entire interior of the building, there will be a reverberant buildup of noise which will in turn increase the exterior sound level of the buildings.

It is therefore concluded that the acoustical design of all the buildings must be handled with considerable care to assure that all the necessary equipment is specified at the appropriate sound level, and is properly enclosed. Attention will be given to the location and size of building openings such as roll doors, ventilation louvers, ventilation fans, etc.

Oxygen Production. Sources of noise associated with the cryogenic oxygen production plant are the intake air compressors, and the reversing valves. The compressor noise is predicted in the same manner as for the other compressors at the plant. Only one of the 4 compressors operates at a time, except during plant turnaround.

The cryogenic plant has been designed with molecular sieve prepurifiers. The prepurifiers remove impurities including carbon dioxide and water vapor from the incoming air by adsorption onto a crystalline medium. To avoid clogging, the sieve is purged with nitrogen gas. The switch valves for purging nitrogen operate briefly only once every 8 to 12 hours, rather than at the 10-minute intervals required for the reversing heat exchangers without the molecular sieve prepuprifiers. The compressor discharge valves periodically discharge gas to atmosphere when pressure exceeds system requirements.

Sound levels have been measured from the reversing valves at two cryogenic plants. The measured levels were 90 dBA at 15 ft and 104 dBA at 10 ft, respectively, from the cryogenic tower. The 104 dBA valve is extremely loud, and if unattenuated, would contribute a sound level of up to 50 dBA in the community (not taking into consideration the effect of atmospheric absorption).

The compressor discharge valves and switch valves and associated piping noise will be reduced 20 to 30 dBA by the provision of acoustical insulation and other mitigation measures for valves and/or piping, as necessary. Gas vent silencers are readily available and provide 30 or more dBA noise reduction for the compressors' discharge valves. The compressors' intakes will be equipped with silencers.

Gas Turbine. The gas turbine used for power generation is a potential source of off-site noise. The dominant noise producers are the combustion air intake and exhaust. Additional significant sources include casing-radiated noise, gas compressor noise, and air filter pulse cleaning, if used. The co-generation capability includes sources of noise such as bypass exhaust, generator, and heat exchanger sidewall noise, as well as forced draft fan noise, if auxiliary boiler firing is utilized. The transformer associated with the power generation is also a source of noise.

The primary means for controlling gas turbine noise is to enclose the turbine generator inside an acoustically treated building or enclosure, as well as the use of large intake and exhaust silencers. The high-frequency compressor noise from the intake is relatively easy to attenuate. Special care must be taken, however, to attenuate the low-frequency combustion noise from the compressor exhaust. In particular, attention must be given to noise in the 31 Hz octave band which, while having little effect on the A-weighted sound level, can vibrate windows and structures if not appropriately mitigated.

A gas turbine with standard silencing is approximately 65 dBA at 400 ft, the standard NEMA (National Electrical Manufacturers Association) distance for measuring gas turbines. This is roughly equivalent to 50 dBA at Point Shirley, which is excessively loud. Approximately 15 dBA of additional noise reduction over standard is therefore required to bring the sound level down to approximately 35 dBA or less at Point Shirley. This corresponds to a NEMA 400-ft sound level of 50 dBA or less.

The state-of-the-art sound level design for gas turbine noise control is approximately 45 dBA at 400 ft for 50 MW gas turbines, so the level of noise control required is attainable. There are several gas turbine installations in this country with NEMA levels of 45 dBA. However, a considerable engineering effort is required to achieve this low sound level.

For the purposes of this report it is therefore specified that the gas turbine to be used on this project will be required to meet a NEMA sound level of 50 dBA or quieter at 400 ft, as well as specific octave band requirements which will prevent low-frequency annoyance.

Diesel Generators. Sound pressure level data for the new fast-track 6000 kw diesels are based upon manufacturer's data. The existing Nordberg diesel pump drives and Enterprise diesel generators are not included in the estimate because they are being replaced with electric motor drives (which are included).

Results

Sound pressure levels were predicted using the sound power levels derived as discussed above. Sound level estimates were made for each of the noise monitoring locations (MWRA 1986). The results of the predictions for the nearest neighbor on Point Shirley are given in Table 11.4.5-3. As can be seen from the table the total sound level at the nearest neighbor is expected to be approximately 36 dBA. This is 3 dBA lower than the residual ambient sound levels measured in the area and will cause a less than 2 dBA increase in the existing ambient sound level under the most favorable noise propagating conditions. This change in ambient sound level will not be noticeable.

The projections indicate that the most dominant noise sources are the gas turbine, the existing pump station open door, and the roll-on/roll-off pier pump. It is not known at this time who will own and control these pumps (they may be on a ship), so no noise mitigation was assumed in

## TABLE 11.4.5-3

## SOUND LEVEL CONTRIBUTION OF EACH NOISE SOURCE AT THE NEAREST NEIGHBOR ON POINT SHIRLEY

| Location | | Sound Level Contribution, dBA |
|---|---|---|
| 1. | North Pumping Station Power facility | 35 |
| 2. | Winthrop Terminal | 12 |
| 3. | Stacked secondary clarifiers | 22 |
| 5. | Aeration (Batteries C,D) | 18 |
| 7. | Aeration (Batteries A,B) | 17 |
| 9. | Oxygen facility | 20 |
| 10. | Primary clarifiers | 15 |
| 11. | South Pumping Station | 16 |
| 12. | Roll-on-roll-off pier | 28 |
| TOTAL | | 36 |

the prediction. The sound level contribution of the other individual sources is relatively minor.

The sound level of each of the sources appears to be very low when considered individually. However, there is not as much allowance for excess noise as may appear. For instance, the quietest 7 sources when grouped together total 27 dBA. If each of these sources were 5 dBA louder, their total would be 32 dB, which, when added to the 35 dBA from power generation, would give 37 dBA. If they were each raised by 10 dB, the total would be 40 dBA. It can thus be concluded that an additional 5 dB can be allowed for building ventilation or other miscellaneous sources without impacting the evaluation goal of 39 dBA.

Deer Island Construction Noise

The construction of the facility will continue over a period of approximately 12 years. During this time numerous buildings, treatment facilities, and earthen landforms will be constructed. This section describes the procedure used to predict construction noise and discusses the expected sound levels at Point Shirley during this period.

During the early portions of the project, the earthen landforms at the northern end of Deer Island will be constructed. This involves the movement and placement of large amounts of earth and will result in a potential noise impact. Once in place, the landforms will provide shielding for the balance of the construction noise. Evaluations of the noise impacts from early site preparation activities are described in Volume VI of this EIR/EID.

In order to reduce the sound level resulting from construction of the berm, the northern edge of the berm will be kept at a 20-ft higher elevation than the back portion of the berm. This will provide shielding of a major portion of the earth hauling and unloading activities on the berm.

Construction noise is predicted using a methodology presented in the Power Plant Construction Noise Guide (Barnes, 1977). This approach is based on actual measurements of a large number of pieces of construction equipment and the monitoring of construction noise at numerous power plant construction sites. For a given set of equipment operating in a given area, the methodology can be used to predict far field sound levels.

The method gives the expected 50 ft sound level for several sizes of each type of construction equipment commonly used. Corrections are then made for the number of pieces of each type of equipment (+10 log N), for the percent of time the equipment is operating (-10 log specified time/reference time period), and the percent of operation time that it is expected to be at full load.

The construction noise was then calculated by tabulating the equipment to be used for each of the on-site construction projects for three month periods, correcting for the factors discussed above. The construction area was divided into three zones of increasingly greater distances from Point Shirley to facilitate the prediction of noise. The total sound level vs time was

then calculated for each zone, extrapolated to the nearest residence, corrected for barrier attenuation, and totaled for the three zones. The atmospheric absorption values described in Appendix D were used for the calculation.

Barrier Noise Attenuation

Landforms will be created along the northern end of Deer Island to provide a visual and noise barrier. The height of this landform will vary from 30 to 110 ft above the general level of Deer Island. The noise attenuation provided by the landforms is a function of several factors including:

- o distance from the noise receiver to the barrier
- o distance from the noise source to the barrier
- o barrier height
- o wind direction

The first factor, the distance from the source to the barrier, is constant. The second factor, however, the distance between the construction equipment and the barrier, ranges to over 4000 ft. The further the source is from the barrier, the less attenuation it provides, although hemispherical divergence attenuation increases.

The barrier height varies from elevation 160 (approximately 30 ft above the general terrain of 130 ft) to 240 ft, with an effective barrier height of 110 ft. Most of the construction work on buildings will occur behind the 200 ft elevation of the barrier, giving an effective barrier height of 70 ft.

The fourth factor affecting barrier acoustical performance is the wind direction. At greatest distances, sound waves refract over a barrier and curve downward in the downwind direction, effectively reducing the barrier height. In a similar manner, the sound waves refract upward in the upwind direction, increasing the effectiveness of the barrier.

A portion of the construction noise is from the equipment used to build the landforms. In order to reduce the noise from the construction of the landform, the northernmost edge of the landform will be constructed with quiet equipment, and will be 20 ft higher than the balance of the landform to shield the landform construction equipment from the residences. This quiet equipment consists of quieted rubber tire, sand front end-loaders which are approximately 72 dBA at 50 ft, as opposed to typical diesel driven equipment which has noise levels in the 80s.

The sound levels at Point Shirley were analyzed with landforms to include both upwind, crosswind, and downwind conditions. The crosswind conditions were represented by using the barrier noise reduction methodology of Maekawa (1971). The upwind condition was represented by a 20 dBA wind shadow. Wind shadows typically range from 20 to 50 dBA. (Berauek 1971)

Although most barrier prediction techniques do not indicate barrier effect degradation with wind, Kurtz and Schreiber's (1986) approach was used to conservatively determine the worst case effect of wind on barrier performance over long distances. This would occur with winds from the S, SE, and E.

The results of the estimates are shown in Figure 11.4.5-1. The curves show that the projected sound levels will vary between the existing minimum ambient level of 45 dBA for a strong upwind condition with the receiver in a wind shadow zone, to 50-54 dBA with a crosswind, where the barrier effect of the landforms are responsible for reducing the noise. This range of sound levels is expected to occur during 83% of daytime hours. During 17% of the daytime hours (annual basis), when the wind has a southeast component, the sound will tend to refract over the barrier and produce levels which may vary from the low 50s to the 60-65 dBA range.

The sound levels were prepared showing construction noise for Point Shirley representative of the loudest construction period, which gives approximately 63 dBA at the nearest neighbor. These contours are given in Figure 11.4.5-2. Not taken into consideration in the preparation of the contours is the 5+ dB reduction in noise observed at the site due to the barrier effect of the first rows of houses of Point Shirley on noise coming from low elevations.

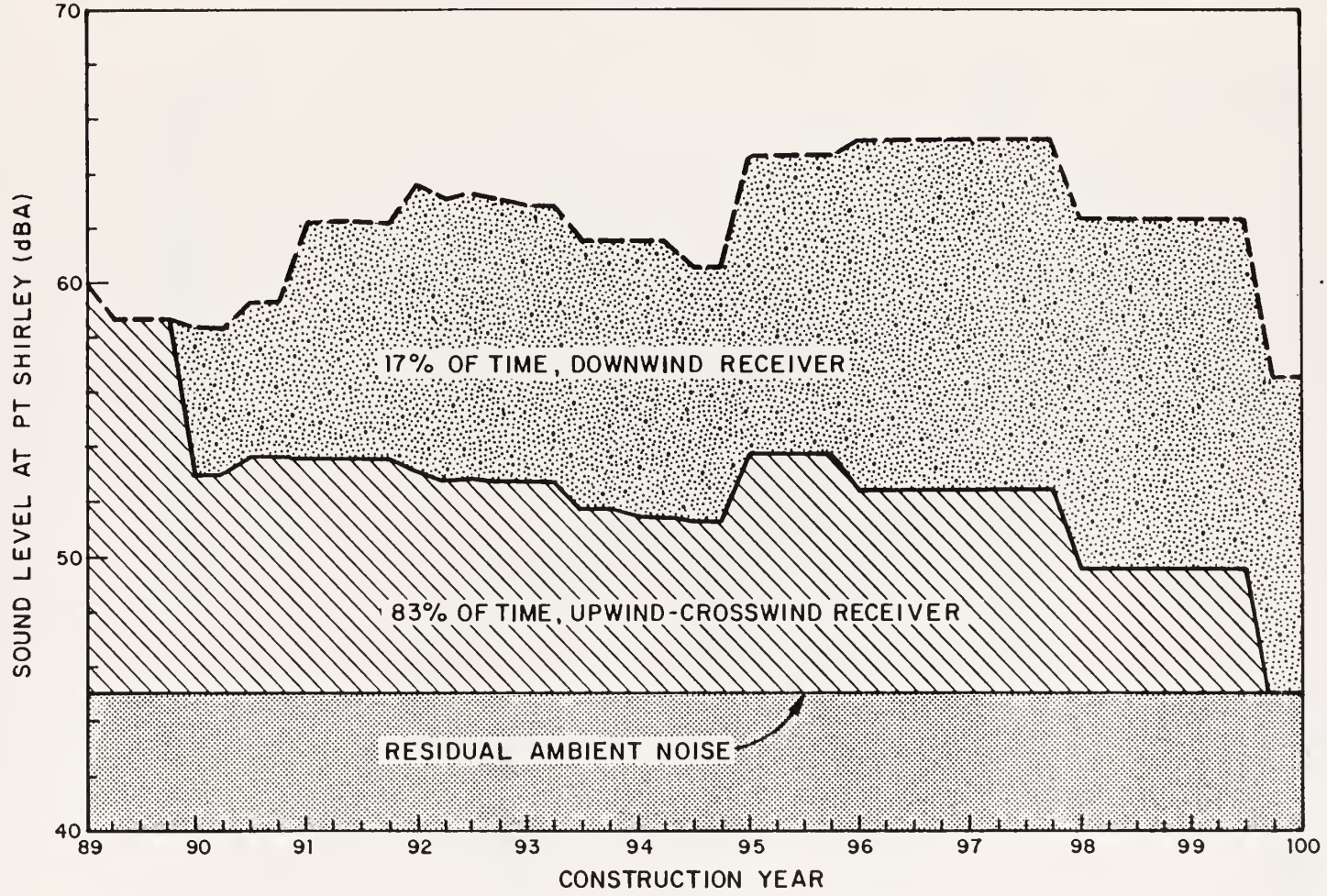
This analysis has indicated that the noise barrier landform is an effective mitigation measure in reducing construction noise by about 10 dBA, for all but 17 percent of the daytime hours. The projected range in construction sound levels of 50 to 65 dBA were compared with the existing ambient, daytime sound measurements taken at Point Shirley. As shown in Figure 11.4.5-3, the existing daytime median, or $L_{50}$ sound levels, which range from 47 dBA to 63 dBA, are similar to the projected maximum construction sound levels.

Under the worst-case conditions, downwind conditions limit the effectiveness of the noise barrier landform. Similar sound levels to the maximum projected for construction are characteristic of the area, and occur 97 percent of the daytime for about six minutes each hour.

As described in Section 11.1.3, Power and Heat Summary and Potable Water and Plant Water System, provision of potable water supply and immediate power to Deer Island will entail construction of a 20-in-diameter water main and a 24-kv power cable in routings through Winthrop. This construction will require the use of a backhoe, front-end loader, and 10-wheel trucks. The work will proceed along the construction routes at the rate of 150 to 200 ft per day. For a given house along the route, the highest sound levels resulting from this construction will occur when the backhoe is directly in front of it. At that time the average sound levels will be 87 and 82 dBA at 50 and 25 ft, respectively. This sound will have a duration of approximately one to two days as construction progresses along the route.

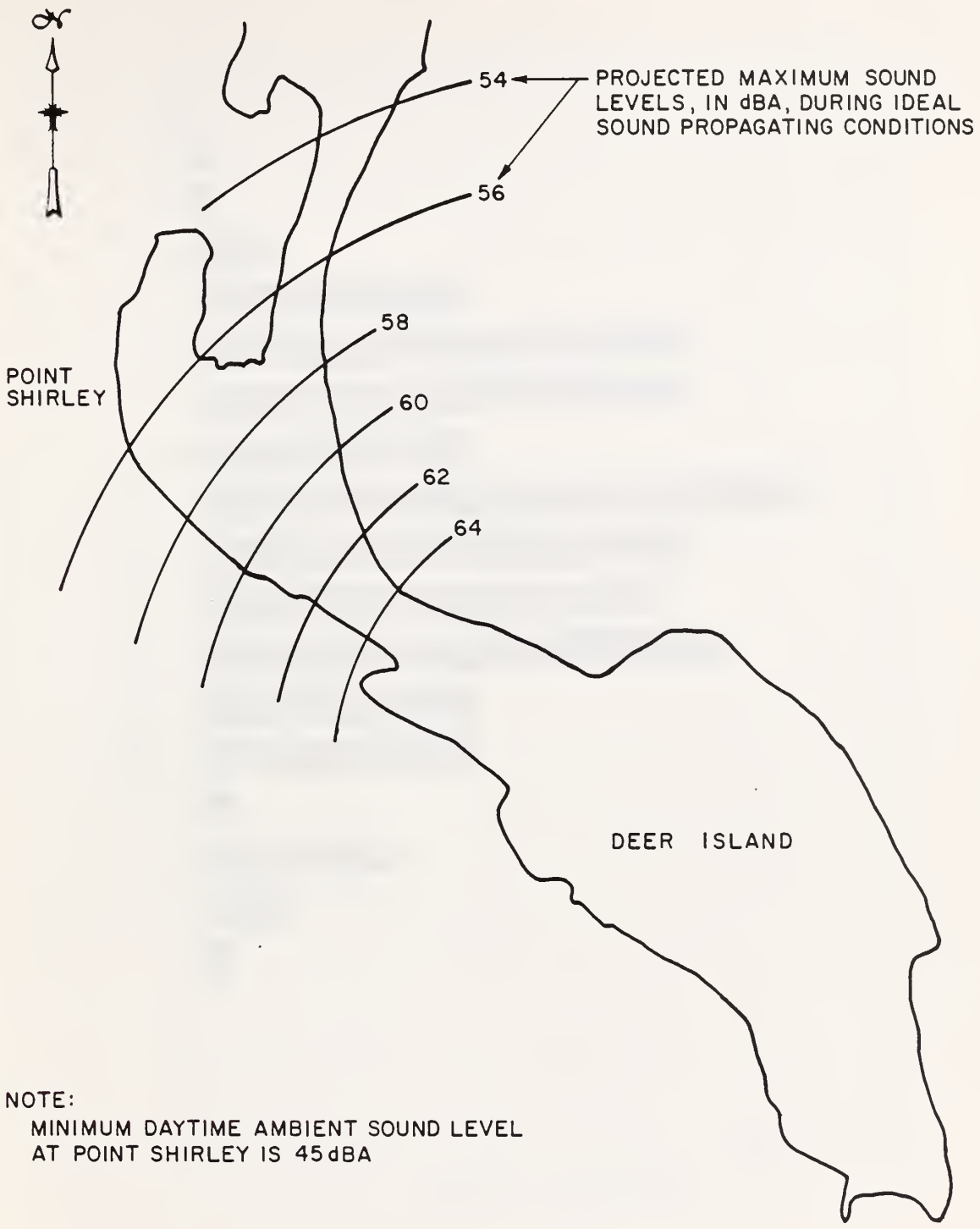
Nut Island Operation Noise

The new headworks facility will provide preliminary treatment to the South System flows prior

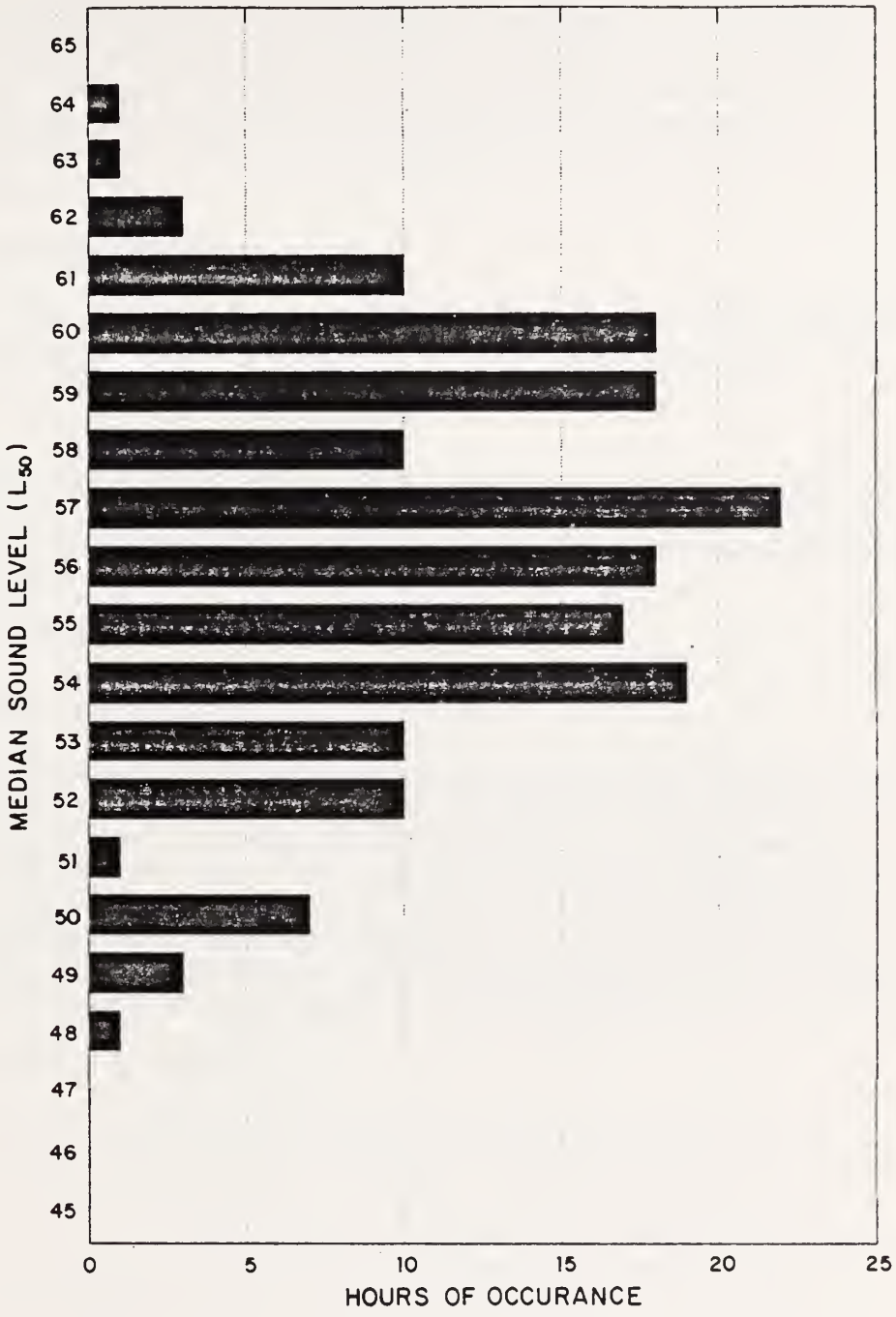



**MASSACHUSETTS WATER RESOURCES AUTHORITY**

FIGURE 11.4.5-1
PREDICTED DAYTIME CONSTRUCTION NOISE LEVELS AT NEAREST RESIDENCE, POINT SHIRLEY




| MASSACHUSETTS WATER RESOURCES AUTHORITY | FIGURE 11.4.5-2<br>MAXIMUM PROJECTED CONSTRUCTION SOUND LEVELS AT POINT SHIRLY, WINTHROP |
|---|---|




| | |
|---|---|
| **MASSACHUSETTS WATER RESOURCES AUTHORITY** | FIGURE 11.4.5-3<br>DAYTIME AMBIENT SOUND LEVELS<br>AT POINT SHIRLEY |

to conveyance to Deer Island. The screenings building will contain equipment for screening and grit removal but will not contain large, loud equipment. It will be fully enclosed and the expected sound levels at the nearest residential area are expected to be less than 25 dBA. The daytime residual ambient sound levels have been reported at approximately 50 dBA. The nighttime ambient sound level has not been measured, but it would be expected to be approximately 30-35 dBA. The screenings building will not be audible at the nearest residential area.

Nut Island Construction Noise

The construction noise for Nut Island was predicted in the same manner as that for Deer Island; however, the amount of construction planned for Nut Island is very small compared to Deer Island. The primary activities consist of the demolition of the existing facility, site preparation, and construction of the new building.

The energy average sound level resulting from the construction is expected to be 63 dBA from mid 1992 to mid 1994, dropping to 60 dBA for the remaining year of the project. This will result in an approximately 10-13 dBA increase over the measured daytime residual sound level of approximately 50 dBA for that period.

## 11.4.6 TERRESTRIAL AND AQUATIC ECOLOGY

Deer Island

Ecological impacts associated with the construction of the secondary treatment facilities, and the landforms that will ring Deer Island will, in many respects, be similar to those described for the Early Site Preparation activities (Volume VI, Section 8.3.6). Sources of potential impact on fauna and flora associated with the construction effort include 1) habitat removal and the subsequent displacement of fauna from cleared areas, 2) the generation of fugitive dust, 3) increased potential for erosion of cleared surfaces, 4) construction generated noise, and 5) the movement of construction personnel, equipment and materials on-site. Each of the above impacts have been assessed for each of the treatment plant activities.

Habitat Removal and Displacement of Fauna

Land clearing for the construction of the secondary treatment facilities will result in the loss of the remaining vegetated areas on Deer Island. These areas consist primarily of the old fields on the east side of the island near the existing treatment plant and the prison, and some shrub areas on the remaining portions of the drumlin. Soils excavated from this area will be used to construct the landforms on the east and northern sides of the island. Island elevations in the landform areas will be raised to a maximum elevation of approximately 240 ft.

The loss of the mixed grassland habitat is expected to have an adverse impact on local wildlife species (birds and small mammals). Surveys of the site have indicated that the island's wooded communities support a variety of faunal species. The presence of raptors such as the sparrow

hawk (Falco sparverius), peregrine falcon (Falco peregrinus) and snowy owl (Nyctea scandiaca) further suggest ample prey in the form of small mammals and insects. A conservative estimate is that fauna (e.g. skunks, raccoons, squirrels and other rodents) displaced as a result of removal of vegetation will be lost from the local population, either directly or indirectly through increased predation stress. Given the "peninsula" nature of the island, the loss of the mixed grassland and wooded habitat and its faunal component, however small, should be considered significant. However, none of the faunal species are endangered, threatened or otherwise unique. All species, except the snowy owl, are common elsewhere in the state (the owl is a winter migrant which spends much of its time in the grasslands at Logan Airport [Smith, 1987]) and are generally compatible with man's activities. Repopulation of suitable areas on Deer Island by these species is therefore expected, upon completion of construction activities. Thus, the loss of these individuals does not constitute an impact of consequence.

Generation of Fugitive Dust

Fugitive dust generated by heavy equipment and/or truck traffic during facility construction has the potential for adverse effects on vegetation in areas adjacent to construction. Dust particles may clog leaf stomata, thereby reducing gas exchange necessary for photosynthesis and respiration. Airborn dust particles can also reduce photosynthesis through a process known as "shading" (e.g., limiting the amount of sunlight reaching the surfaces of green plants). Vegetative communities on Deer Island, during the construction phase, will be limited to small areas around the perimeter of the island, and areas which have been stabilized and replanted within the construction zones. All of these areas will be primarily grassed and thus will be fairly resistant to impacts from fugitive dust. In addition, dust on-site will be controlled by the use of water spray trucks to dampen exposed surfaces. Thus, no adverse impact of dust on vegetation in adjacent communities is expected.

Increased Potential For Erosion

Surfaces which are under active construction generally are highly susceptible to erosion. Because of this, a mitigation program will be necessary at Deer Island to control erosion and prevent sedimentation into adjacent areas, particularly tidal wetlands. The mitigation program will ensure that runoff from exposed surfaces will drain to settling basins, holding ponds, hay bale barriers and/or silt fences, as appropriate, prior to discharge to the harbor. Temporary stabilization of graded areas will be accomplished by seeding, tacking or mulching until permanent cover is established. Hay bales and drainage ditches will be used to prevent sedimentation into adjacent areas.

Construction Noise

Noise related to construction activities has the potential for disrupting behavior patterns of wildlife species inhabiting communities adjacent to construction areas. Noise from heavy equipment, for example, may be sufficiently loud and intrusive to disrupt normal behavior patterns of birds and mammals through a phenomenon known as "masking" (e.g. interference with normal auditory or communication signals). However, since the areas surrounding the early site

preparation construction zones do not support appreciable numbers of wildlife species at present, the effects of construction-related noise should be minimal.

Movement of Personnel, Equipment and Supplies

Because of the intense level of activity which will occur during the facility construction phase, the presence of numerous vehicles on-site would ordinarily have a deleterious effect on the wildlife inhabiting adjacent communities, primarily through roadkills and the disruption caused by the movement of equipment, personnel and supplies. However, since the areas adjacent to the construction zones currently do not support large numbers of faunal species, no long-term deleterious impact is anticipated.

Operational Impacts

Impacts during the operational period will result from natural sources, from plant operations and from human use of the restored areas. Natural sources are defined primarily as weather conditions, which may be severe on the occasion of coastal storms, due to the exposed nature of the island. Selection of the plant species to be planted as part of the mitigation program will, however, include tolerance of these conditions as an important factor.

The primary sources of plant operation impacts include noise and air quality concerns. With any new source of noise, the masking phenomenon may affect wildlife immediately adjacent to the source. However, the presence of the landforms and the low level of plant noise (Section 11.4.5) is expected to result in rapid adaptation on the part of animals using the site.

There will be two major sources of gaseous releases on the site, including an electrical power plant and vented gases. The power plant emissions will be controlled by the Best Available Control Technology, and vented gases will be passed through a two stage air emission treatment system to remove volatile organics (Section 11.4.2). In both cases all air emission standards will be maintained and no adverse impacts are anticipated.

Recreational use of the restored portions of the island will to some degree be determined by the nature of the open area to be created at the north end of the island. It is anticipated that some passive recreational use of the landforms will be permitted. However, the inaccessibility of major portions of the island will limit recreational use to a bare minimum. Very little impact from recreational use is therefore anticipated.

Mitigation

Mitigation efforts at Deer Island will be concentrated primarily on the landforms to be constructed along the island's perimeter. The landforms will be topsoiled and planted so as to support a heterogeneous vegetative community comparable to that which is presently on the island. The plant species will be chosen to be able to withstand the rigors of the exposed location, be indigenous to New England's coastal plain communities, and be able to provide cover, breeding and nesting areas for local fauna. Where possible, artificial structures such

as perches and platforms will be constructed to enhance the wildlife uses of the area until mature vegetation can become established.

The primary goal of the mitigation program will be to enhance the prey base for the raptors (hawks and owls) which presently visit the island. In addition to the kestrals, peregrines and snowy owls which have been seen on the island, these species are apt to include the northern owl (Circus cyaneus), short-eared owl (Asio flammeus) and barn owl (Tyto alba), all of which are uncommon in Massachusetts (Nickerson, 1987; Smith, 1987; and French, 1987). This will require the creation and occasional maintenance of grassland, to be used by raptors as hunting areas; these areas may include clumps of shrubs and trees, to serve as resting areas and to attract small birds and mammals.

Nut Island

Construction Impacts

Ecological impacts associated with the construction of the headworks at Nut Island will be less severe than the impacts of the secondary treatment facility construction at Deer Island. In the case of Nut Island, all natural vegetation and associated faunal habitat have long since been removed during previous activities on the site. Impacts will therefore be limited to 1) the generation of fugitive dust, 2) increased potential for erosion of cleared surfaces, 3) construction-generated noise, and 4) the movement of construction personnel, equipment and materials on-site.

The concerns associated with these sources of impacts, as with Deer Island, are greatly reduced because of the absence of adjacent terrestrial communities. A construction mitigation plan similar to the one recommended for Deer Island will be used at Nut Island in order to provide the same level of environmental protection.

Operational Impacts

Few if any negative impacts are anticipated from the operation of the headworks on Nut Island. Noise levels from the facility will be less than current ambient nighttime levels (Section 11.4.5), and gaseous releases are controlled and treated (Section 11.4.2). The major activity on the island other than the headworks will be passive recreation in the open-space area (Section 11.4.3). The open-space area will also permit an increase in the use of the area by wildlife.

Mitigation

Of the 17 acres presently covered by facilities on Nut Island, only a few will be occupied once the construction of the new headworks is completed. The remaining acreage will be landscaped to provide a park-like open area for passive recreation. This area will more than likely include trees and shrubs as well as grassed areas. Woody vegetation chosen for the site will include some intended to provide resting, nesting and feeding areas for traditional suburban

wildlife such as passerines (song birds), skunks, raccoons, squirrels and other rodents. The intertidal zones will also be used by sandpipers and plovers, and an occasional visit by raptors might be expected.

## 11.4.7 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Deer Island, owned by the City of Boston since 1634, has traditionally been used as a site for purposes that had to be set apart from populated areas. The City's development on Deer Island of its correctional facilities and its wastewater treatment/disposal facilities, both dating from the 19th century, represent the City's response to social and urban problems resulting from a rapidly growing population. Historical and archaeological resources on Deer Island consist of the following:

- o Hill Prison
- o Prison Superintendent's House
- o Steam Pumping Station
- o Farmhouse
- o New Resthaven Cemetery

The following section provides a summary description of the historical and archaeological resources on Deer Island; considerations given to potential preservation and reuse of these resources, compatible with the treatment facility site planning needs; impacts of site development on these resources; and proposed measures which would mitigate impacts on these resources.

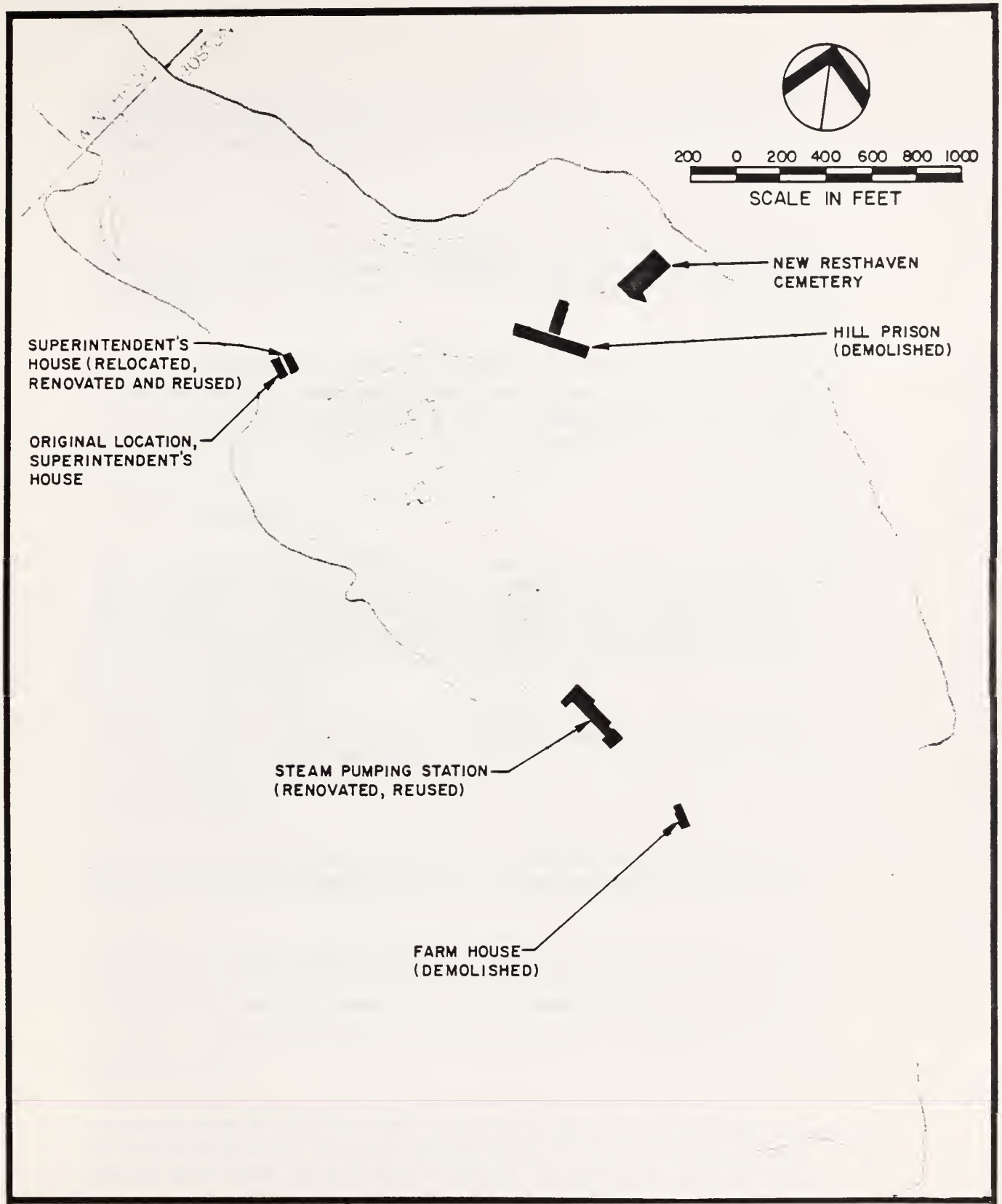
Previous investigations have not indicated the existence of any historical or archaeological resources on Nut Island.

### Existing Historical and Archaeological Resources

Section 5.3 and Appendix O provide a detailed description of the archaeological and historical structure surveys conducted on Deer Island for the secondary treatment facilities planning project, and the findings of these surveys. The locations of the historical and archaeological resources on Deer Island which are affected by this project are shown in Figure 11.4.7-1.

### Secondary Treatment Facilities Site Planning

The construction of the new treatment facilities on Deer Island is a massive undertaking which will reshape the island and affect every existing structure. In developing the proposed site plan for the treatment facility, numerous technical, environmental, institutional, and mitigating factors were considered, which are described in Sections 9.1 and 9.3. The major factors which have shaped the proposed Deer Island site plan include transportation to and from the island during facility construction and operation; the undesirable environmental and visual effects of the treatment plant; the selected technology for the plant; the desirability of minimizing the removal of excavated materials from the island; and the


200 0 200 400 600 800 1000
SCALE IN FEET
NEW RESTHAVEN CEMETERY
HILL PRISON (DEMOLISHED)
SUPERINTENDENT'S HOUSE (RELOCATED, RENOVATED AND REUSED)
ORIGINAL LOCATION, SUPERINTENDENT'S HOUSE
STEAM PUMPING STATION (RENOVATED, REUSED)
FARM HOUSE (DEMOLISHED)

MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 11.4.7-1**
**DISPOSITION OF HISTORIC/ARCHAEOLOGIC RESOURCES ON DEER ISLAND**

limited land area available on the island. These forces, as described below, have guided the development of the treatment facilities site plan which impacts on the historic and archaeological resources of Deer Island.

Transportation

Deer Island is accessible either by ground transportation through Winthrop or by water transportation across Boston Harbor. To mitigate the effects of construction and operations traffic through Winthrop, the MWRA has undertaken to provide water transportation facilities to Deer Island.

From a topographical viewpoint, the most suitable place for locating piers on Deer Island is on the southwest side of the island, near the Steam Pumping Station. The selection of this site as the entry point to the plant determines the location of residuals facilities, which must be sited near the piers, and administrative facilities, which also should be near the entry point to the island.

Protection for Winthrop

The community of Winthrop will be afforded protection from undesirable effects of the treatment facility both through the design of the site plan and through the use of visual and noise screening barriers. The elements of the treatment facility having the greatest potential for nuisance odors are the residuals handling facility, and preliminary and primary treatment facilities. The site plan provides for location of these elements on the southern part of Deer Island, away from Winthrop.

Landforms will be constructed on the northwest, north, northeast, and south sides of Deer Island to provide visual and noise screening.

Treatment Technology

The treatment technology selected for Deer Island has two main effects on the site plan: it determines the overall area needed, and it sets the elevations of the primary and secondary clarifiers.

The selected treatment technology incorporates design features which minimize overall land requirements: stacked primary and secondary clarifiers and oxygen activated sludge process treatment will be used. The elevation of the primary clarifiers will be at approximately 154 ft to allow a north-to-south gravity flow through the system with no intermediate pumping.

Earth Movements

A constraint of the site plan is the desire to minimize the amount of earth that might have to be removed off the island. This goal is desirable because of the cost of barging excavated materials off the island, and the problems of disposal. The selected plan places the highest

elements of the plant, the primary clarifiers, near the location of the highest existing point of the island, the central drumlin, thereby minimizing the amount of earth movement. The site plan also provides for the reuse of a portion of the excavated materials through the construction of on-site landforms which provide visual and noise screening.

Limited Land Area

Usable land area for the primary and secondary treatment facilities is much less than the total acreage of Deer Island, considering that not all of the available land can be used. Functional relationships between treatment process units must be maintained within the constraints imposed by the shape of the available land.

The treatment plant and associated facilities are extensive because this plant will be the sole wastewater treatment plant serving the Boston Metropolitan Area. The selected site plan provides for area requirements of three major MWRA projects: Water Transportation (i.e., Piers); Primary and Secondary Treatment; and Residuals Management. The land requirements for each of these projects have resulted in the need to use virtually all of the land area on Deer Island, and in reduction of the flexibility allowed in planning for reuse of historic structures.

Effects of Site Development on Historical and Archaeological Resources

Figure 11.4.7-1 illustrates the recommended selected site plan for Deer Island. The effects of the proposed facilities on the historical and archaeological resources of Deer Island are described below:

Hill Prison - The Hill Prison is located in that portion of the island which is set aside for the stacked secondary clarifiers. Changes to existing grade will be made to facilitate gravity flow through the treatment plant.

The following alternatives were considered for this structure:

1. Reuse of the Hill Prison at its existing location - For several reasons, this alternative was determined to be infeasible. The limited land area of the island would make it difficult to place all the necessary treatment tankage on the island if the Hill Prison were retained: the necessary functional relationships between the process units would be distorted; the operability and maintainability of these units could be affected. The need for maintaining a cost-effective gravity flow through the treatment plant would also leave the Hill Prison isolated at a significantly lower elevation from adjoining land.

   Furthermore, if the building were to be retained, it would need a new use. After considering the potential uses of this building, it was concluded that its location would be problematic for use as administrative offices, as it is not near the piers;

and the multilevel building would not lend itself to an efficient administrative and laboratory space.

2. Moving the building - The Hill Prison is over 320 feet long, has a 150-ft wing, and is over 50 feet high. Moving this building could be accomplished only at enormous cost and effort. Even if it could be moved and relocated on the island, a new site would have to be found, and the use of land for a building which does not lend itself to efficient reuse would put additional pressure on already tight land availability constraints. This alternative was determined to be infeasible.

3. Documenting and demolishing the building - A final alternative considered was the documentation of the building for the Historic American Building Survey, before demolition.

Conclusion - The Hill Prison will be demolished as part of this project. The House of Correction operations are being moved to another location off-site; the site of the Hill Prison is needed for treatment plant facilities; and the land elevation will be changed. The building cannot be moved. Before demolition, it is proposed that the building be recorded for the Historic American Buildings Survey.

Superintendent's House - The Superintendent's House is located in a section of the island where a landform is being constructed to mitigate noise and visual effects of the project. Since the House of Correction is being moved off Deer Island, this building no longer has a function as part of the prison complex.

The following alternatives were considered for this building:

1. Reuse of the building at its present location - The present site of this building is planned to accommodate a landform, screening Winthrop from the nose and visual effects of the treatment plant. This alternative is therefore not feasible.

2. Moving the building - It is feasible to move this building, although the cost will be significant. New foundations matching the appearance of the existing stone foundations would have to be constructed, and the building moved from the first floor up. A proposed location for the Superintendent's House is shown in Figure 11.4.7-1. This location allows for reuse of the building in connection with future security plans required for the new treatment facility. The location is strategic since it stands alongside the only landward transportation access point to Deer Island.

Conclusion - The Superintendent's House would be moved and reused as a security center for the new treatment plant.

Steam Pumping Station - The Steam Pumping Station is situated near the water where the proposed piers will be constructed. It has been possible to plan the treatment plant facilities without

encroaching on it. Figure 11.4.7-2 shows plan and elevation views of the existing Steam Pumping Station structure.

Since there is a need for space for administrative and laboratory functions, the project proposes to reuse the structure for these purposes. Approximately 40,000 square feet would be needed to accommodate the administrative offices and laboratories; the Steam Pumping Station could be adapted to provide approximately one half of this area. Thus, the building would have to be enlarged to serve the administrative and laboratory space requirements. Several alternative layouts have been proposed for adaptation of the Steam Pumping Station. Figure 11.1.3-35 shows an example of an alternative concept which provides for the additional building area requirements, and minimizes alteration to the front of the existing structure.

Reuse of the Steam Pumping Station, as described, will require modifications to the building interior. Since the building is historically significant as an engineering landmark, it is anticipated that a review of the existing machinery and equipment would be performed to determine whether it has historical significance. If found to be significant, and depending on the ultimate use for the building interior (to be determined in a Memorandum of Agreement, pursuant to the Section 106 Review), it may have to be recorded and documented for the Historic American Engineering Record.

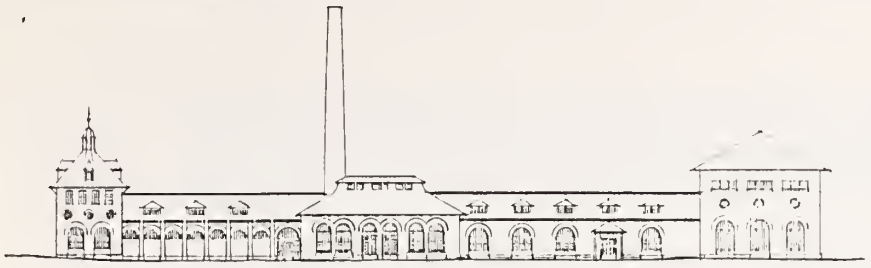
Farmhouse The Farmhouse is situated in a section of the island where the piers, residuals management, and secondary treatment facilities intersect. Because this site is needed for development of the access to treatment plant and residuals management facilities, and is in the path of construction activities, the building is in a poor location for site planning purposes.

Alternatives considered for this building included the following:

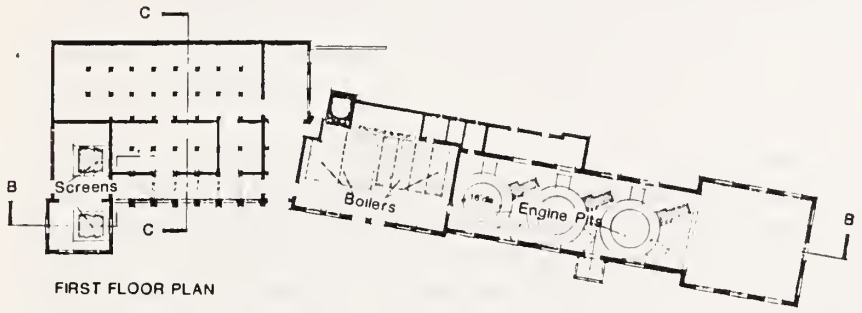
1. Reuse as a personnel shelter - A building need which has been identified by the On-Island Water Transportation Facilities Project consists of a personnel shelter to accommodate persons waiting to be transported from the island to mainland termini. The structure would serve both during construction and operation phases of the Deer Island projects.

   The Farmhouse was reviewed to determine whether it could serve as a personnel shelter. It has been concluded that this possibility is not feasible due to the existing location of the Farmhouse, relative to the piers. Moving the Farmhouse was determined not to be feasible because of the design of the Farmhouse, i.e., there is no floor structure at the first floor level; and its current poor condition would require extensive renovation.

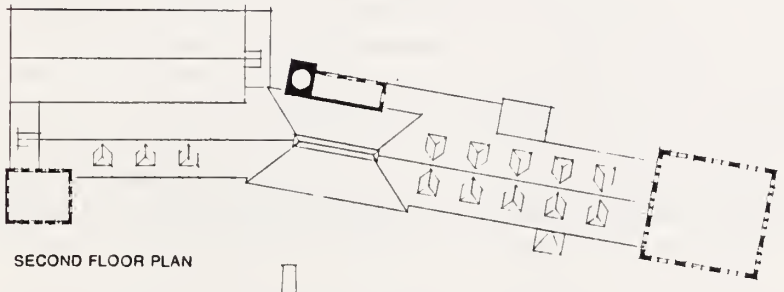
   The building provides only approximately 3,000 square feet and is too small for the programmed needs of the personnel shelter, which include a waiting area, restrooms, and field offices. The Building Code does not permit an A-3 Assembly use in a woodframe building exceeding one story or 20 feet in height. For all of these reasons, the building cannot be used as the personnel shelter.



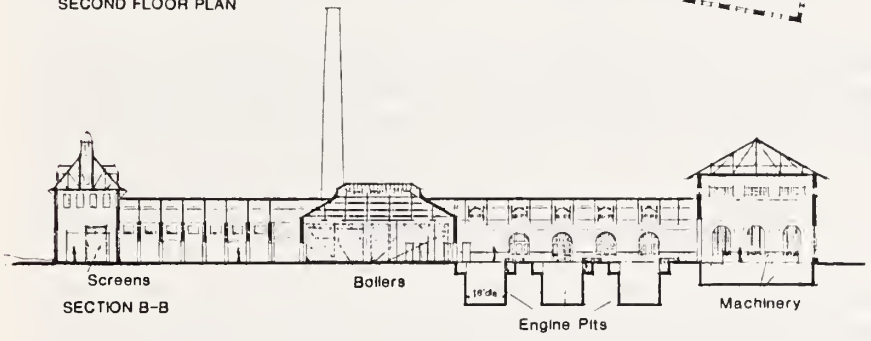
ELEVATION




FIRST FLOOR PLAN



SECOND FLOOR PLAN




SECTION B-B

SECTION C-C

**MASSACHUSETTS WATER RESOURCES AUTHORITY**

**FIGURE 11.4.7-2**
**EXISTING CONDITIONS**
**STEAM PUMPING STATION**

2. Reuse for other purposes - A review of site plans for all three MWRA projects requiring land and building availability on Deer Island was conducted to determine whether other uses could be accommodated by the Farmhouse. None have been found.

3. Documenting the building and demolishing it - A final alternative considered was the documentation of the Farmhouse for the Historic American Building Survey, prior to demolition and use of the land for other purposes described above.

Conclusion - The Farmhouse should be documented for the Historic American Building Survey, and subsequently demolished.

New Resthaven Cemetery - As shown in Figure 11.4.7-1, the Cemetery is located in an area of the island for which a major mitigating measure to the adjoining community of Winthrop - the construction of visual and noise barrier landforms - has been proposed. Construction of the landforms in this location would add approximately 30 to 40 feet of excavated materials to the existing grade at the cemetery. As described in Section 11.4.3, consideration may be given to providing a bicycle path which would traverse the seaward edge of the Cemetery.
As described in Section 5.3, the subsurface studies performed on the Cemetery found that burial remains are in a poor state of preservation. Removal of the remains to any other location would be undesirable, and would be expected to have adverse impacts on the integrity of the burials. It is therefore proposed that the Cemetery be left intact: the addition of fill material to the surface of the Cemetery will serve both a major mitigation purpose relative to community impacts, and will act as an appropriate preservation measure for the Cemetery. The addition of fill material and location of a bicycle path at the edge of the Cemetery would not be expected to affect the burials, given their current state of preservation.

Consideration of additional mitigative measures to the Cemetery, including documentation of its location, provisions for the erection of permanent boundary markers and relocation of the existing concrete cross on top of the new Cemetery grade, will be given in the Memorandum of Agreement pursuant to the Section 106 Review.

Summary of Impacts on Historical and Archaeological Resources

Careful consideration has been given to the development of a site plan for Deer Island which minimizes the effects of site development on historical and archaeological resources, consistent with the technical, environmental, institutional, and mitigating objectives for the project. Proposed impacts to these resources are summarized as follows:

- Hill Prison - Following documentation for the Historic American Building Survey, the building would be demolished;

- Superintendent's House - The building will be moved to a new location and will be reused as a security facility for the new treatment plant;

- o Steam Pumping Station - Following the addition of new building space to the rear of the building, the Steam Pumping Station will be reused to house administrative and laboratory functions for the new treatment plant;

- o Farmhouse - Following documentation for the Historic American Building Survey, the building will be demolished;

- o Resthaven Cemetery - To serve the combined purposes of providing a mitigating noise and visual barrier, and to preserve the Cemetery, approximately 30-40 feet of excavated materials will be added to the existing grade of the Cemetery.

In accordance with the Section 106 Review requirements, a Case Report will be prepared for the project which will document these considerations and propose mitigating measures for the historical and archaeological resources. Following public review, review by the State Historic Preservation Officer, and consultation among the agencies involved, a Memorandum of Agreement will be signed between the MHC, EPA, and MWRA which will finalize the disposition of the historical and archaeological resources, as well as any commitments for preservation and mitigation of impacts.

## 11.5 INSTITUTIONAL CONSIDERATIONS

### 11.5.1 OPERATION AND MAINTENANCE ORGANIZATION

The MWRA wastewater treatment facilities will include the Deer Island Wastewater Treatment Plant; the three existing North System headworks, and the new Nut Island Headworks.

The new treatment facilities will require a significant expansion in the number of staff, the degree of staff skills, and the systems used to operate and maintain these facilities. To provide a realistic assessment of the required numbers of staff and their skills, a prototype operational concept is described in the following sections. This organizational concept, while prototype only, will identify many of the issues that MWRA will have to manage in order to build its operational capability concurrently with the building of the new facilities. It is strongly recommended that MWRA develop its final operational concept at the earliest possible date. As discussed below, the final operational concept is an essential piece of information for facilities design, construction and start-up and is required at an early date to provide the lead time needed to prepare for full operational start-up of the primary (1993-1995) and secondary (1999) facilities.

The present treatment and headworks facilities have operated autonomously from one another, but under the same departmental umbrella, for some time. Operations and maintenance staff have been assigned to each facility while the laboratory and administrative functions have been carried out at Deer Island. Staffing levels at Nut Island and the remote headworks have been somewhat easier to maintain than at the Deer Island facilities. This has resulted in many changes to the Deer Island plant's organizational structure in an attempt to find a way to attract additional employees to the facility. The amount of overtime required at Deer Island

has been high because of many position vacancies. An effort has been made recently to upgrade salaries and benefits and to resolve recruitment problems of this type with an eye toward future staffing needs of the new facilities. It is also believed that the difficult commute to the Deer Island site has been detrimental to attracting personnel and may limit the area around the site in which recruiting can be effectively accomplished.

The objectives of the organizational concept include:

- o Provide effective management and supervision of a large staff.
- o Guide the staff towards achievement of the Authority's objective of effective pollution control.
- o Direct staff to maintain high productivity.
- o Provide an efficient structure for information flow.
- o Provide support functions to operating staff.
- o Minimize operations and maintenance costs while attaining performance objectives.
- o Establish accountability through all staffing levels.
- o Provide career ladder for employees.

The prototype system, or one of a similar structure, is used at most of the large wastewater treatment facilities throughout this country. It is easy to expand or to change as the needs of the facilities complex change over the years. Another strength of the prototype organization is that the structure allows for the effective placement of all personnel as the phased construction is completed and the existing facilities are modified or dismantled. The new primary facilities are scheduled to be fully on line in 1995. The personnel assigned to operate and maintain these facilities will, through experience and training, become the "core group of employees" that will eventually operate and maintain the secondary facilities that will be operational by late 1999.

In addition to the organizational structure discussed herein, the MWRA should carefully evaluate the use of private contractors to operate certain key areas of the recommended facilities. The power and oxygen generation systems are prime facilities that should be considered for private operation in order to obtain the most efficient, reliable operation of these facilities. As discussed under the evaluation of the oxygen facilities, as a minimum, the yearly turnaround of the cryogenic facilities should be considered for outside contract. The overall maintenance program should be carefully evaluated to determine if certain other maintenance tasks could be best performed by highly qualified, specialist contractors or equipment vendors.

Prototype Organizational Structure

The MWRA Wastewater Treatment prototype organization discussed in this section fits within the Authority's organizational structure as follows: The Authority is divided into two Divisions (Water and Sewer); the Sewer Division is divided into a number of Departments including Operations, Water Quality and Maintenance Engineering. The Deer Island Wastewater Treatment Facilities fall under the jurisdiction of the Operations Department. The prototype organization is then structured into sections which are further divided into process units or teams as applicable.

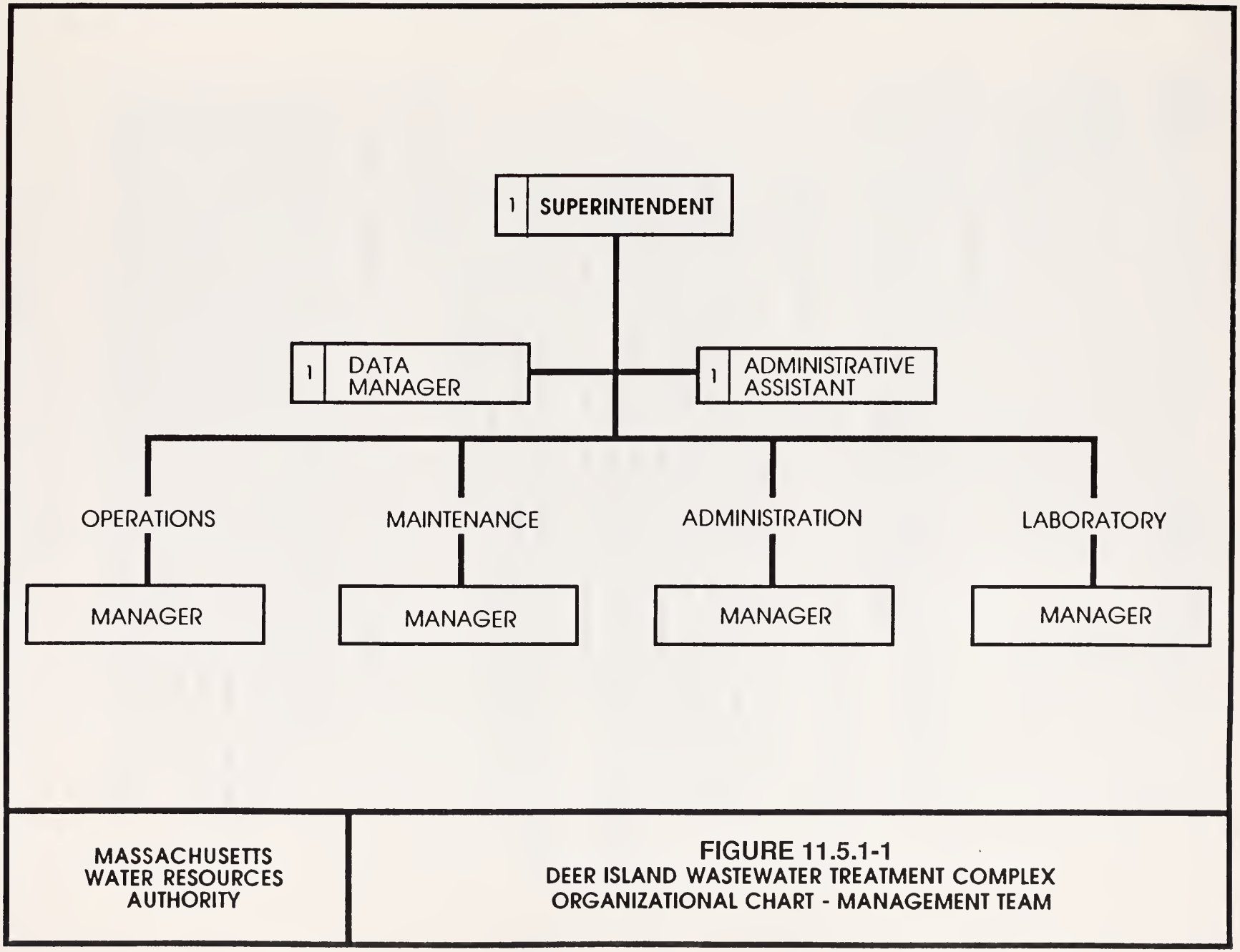
The prototype structure based on the section approach has the goal of meeting the organizational objectives by providing (1) simplicity of structure; (2) minimization of the number of position titles; (3) broad-based position descriptions; (4) a team concept throughout the organization; and (5) a structure that provides a career ladder for employees. The prototype organization will be structured into four sections:

1. Operations
2. Maintenance
3. Administration
4. Laboratory

The team concept within the organization breaks down the staff into smaller, more manageable numbers with three major groups made up of management, supervisory and staff personnel dispersed throughout the four sections. The team concept is illustrated in Figure 11.5.1-1. The generic position titles are listed under the appropriate team and complex section. The numbers in parentheses following the titles within the section indicate the number of teams (if more than one) assigned to those particular functions or units.

Tables of organization that describe, in general terms, the functional responsibilities that will need to be accomplished by each section and the units within the sections are included in Appendix G. Also included are recommended organizational charts for the entire organization by section and units within the sections. Job titles are indicative of the functions that need to be accomplished in the new section structure and are not intended to match existing job titles or position descriptions.

The prototype organizational structure is also broken into four distinct sections, each requiring different skills for the assigned personnel. These sections are: (1) Operations, (2) Maintenance, (3) Laboratory, and (4) Administration. The personnel requirements of each section in the year 1995 when the primary, disinfection, power generation and some of the residuals process units are online; and in 1999, when the total facility will be operating, are as follows:




MASSACHUSETTS WATER RESOURCES AUTHORITY

**FIGURE 11.5.1-1**
**DEER ISLAND WASTEWATER TREATMENT COMPLEX**
**ORGANIZATIONAL CHART - MANAGEMENT TEAM**

| Section | Personnel Required | |
|---|---|---|
| | 1995 | 1999 |
| Operations | 172 | 209 |
| Maintenance | 205 | 275 |
| Laboratory | 12 | 16 |
| Administration | 30 | 40 |
| Total Personnel | 419 | 540 |

Sewerage Division Coordination

Some of the functional units within the Deer Island treatment facilities, though autonomous in functional structure, must work with units and under management systems established by and controlled from the Sewerage Division's Central Office. Examples are:

1. Various functions in the Personnel Department such as timekeeping, benefits, labor relations, purchasing, budgets, etc.

2. The laboratory at Deer Island, which is designed as a process control, permit requirement and troubleshooting unit to provide timely results for maximizing plant performance. The process control test results will include all sampling and analysis performed to control the facility's various unit processes. The permit requirement testing will include all analysis required for meeting conditions of the effluent discharge permit including metals analysis and toxicity tests. Laboratory personnel will work on occasion with the Sewerage Division's Central Laboratory, exchanging data on plant results and the Division's industrial pretreatment program.

3. The Maintenance Section Replacement Engineering Unit, which will be the Deer Island arm of the Sewerage Division's Maintenance Engineering Department staff, working under the direction of the Maintenance Manager but providing requested information to the Division's Maintenance Engineering office.

Functional Description

The prototype organization, as structured, is intended to function in the following manner:

The superintendent will provide the overall policies and direction that the Treatment facilities staff will follow. The Superintendent will be supported in establishing and implementing these policies and directions by a management team consisting of four section managers heading the four sections listed above. The Superintendent will also be supported by two staff personnel who will provide data (information) and administrative support. Additional administrative, financial and personnel support will come from the Administration section as required. All other duties will be delegated to one of the four section managers. This organization places the details of everyday activities at the section level. This allows the Superintendent to look at the broad picture and work with the section managers in setting up

effective management systems that will implement changes and resolve problems in a timely manner. The Superintendent also provides the link to the other departments within the Sewerage Division of the Authority.

The four section managers are supported by a second level of management, known as the supervisory team, who will be the leaders of the various units within a section. This team includes all the assistant managers, directors, supervisors, foremen, and other personnel assigned to a section and reporting directly to the section manager. This breakdown in the chain of command and position titles is apparent in the Organization Charts included in Appendix G. In establishing the functional units within a section, the major criteria considered were the span of control of the managers and the various supervisory members of the team. The four sections are broken into functional units or groups and each is assigned certain areas of responsibility within the total structure. These areas are small enough to provide management with control of the unit and establish accountability of performance of the staff personnel assigned.

Position Identification, Placement and Training

Position Descriptions

After establishing the (1) Functional Table of Organization (section responsibilities); and (2) Organizational Charts (titles and numbers of employees required to accomplish the tasks) as illustrated in Appendix G; the third part of the structure, the Position Descriptions, must be established. Position descriptions identify an employee's duties and responsibilities, and the qualifications to successfully fulfill a particular employee's position. These descriptions must have a formal and consistent format and one position description should be prepared for each position shown on the organizational chart. The position descriptions should include:

1. General Statement of Duties
2. Supervision Received
3. Supervision Exercised
4. Examples of Duties
5. Special Duties
6. Entrance Requirements and Qualifications
7. Special Working Conditions
8. Salary Classification

A few sample position descriptions are also included in Appendix G.

The position descriptions, when prepared, will detail the skills needed by employees being placed in the prototype organizational structure. A sample of some of those position skills follows:

| Position | Basic Skill Requirements |
|---|---|
| Operators | 5 years' wastewater experience, Class III certification. Mathematical and mechanical aptitudes. |
| Attendants | Mathematical and mechanical aptitudes. |
| Unit Foreman | 6 years' wastewater experience, Class V certification (minimum), 4 years' supervisory experience. |
| Shift Supervisor | 8 years' wastewater experience, Class VI certification, 3 years' "responsible charge" supervisory experience. |
| Assistant Managers | 12 years' experience, Class VII certification, 6 years' "responsible charge" management experience. |
| Operations Manager | 15 years' experience, Class VII certification, 10 years' "responsible charge" management experience, degree in engineering or related science. |
| Maintenance Manager | 15 years' experience in maintenance and repair, 6 years' experience as working supervisor, degree desirable. |
| Chief Scheduler | 10 years' experience in scheduling maintenance work, 5 years in supervision, experience with computerized maintenance management systems. |
| Maintenance Foreman | 6 years' hands-on maintenance experience, 4 years' supervisory esperience, 2 years' computerized maintenance experience. |
| Mechanics, Welders, Machinists | Should have qualifications of a journeyman in the craft area of responsibility. Completion of apprenticeship programs is highly desirable and required for some positions. 5 years' actual experience is required. |

Other position descriptions are somewhat self-explanatory, but actual qualifications must be written into the descriptions during their preparation after the Authority adopts a final organizational structure. From the brief overview presented above, it is apparent that a wide range of skills, experience, education, and in the Operations Section, certification as a Commonwealth of Massachusetts Wastewater Operator, will be required in the overall organizational structure from the Superintendent to the laborers' levels.

Staff Size and Skill Requirements

The Deer Island facilities' prototype organization will require a large complement of personnel. The four sections will be large staffs within the organization requiring strong leadership by the Assistant Managers. The following discusses the size of the staff, the basic skills required and the importance of an effective recruitment and retention strategy as discussed in Section 11.5.2 (Training and Staff Development).

The organization is divided into five employee groups corresponding to the four sections described earlier in this section. The staff will number about 540 people, who will be assigned as follows:

| Employee Group | Personnel Required | |
|---|---|---|
| | 1995 | 1999 |
| Superintendent's Office | 3 | 3 |
| Operations | 169 | 206 |
| Maintenance | 205 | 275 |
| Laboratory | 12 | 16 |
| Administration | 30 | 40 |
| Total | 419 | 540 |

The present staff of about 260 (Deer Island, Nut Island and 3 Headworks) should be reviewed, evaluated, and skill-tested for placement in the new prototype organization. The additional people required to bring the staff up to the required 1995 and 1999 levels will be recruited and placed as the new facilities are constructed and approach the start-up phase of the project. The Superintendent's Office, Maintenance, Laboratory and Administration personnel will be assigned to steady day shifts. The Operations personnel will work shifts covering the facilities 7 days per week/24 hours per day/365 days per year. The Operations staff will be scheduled to minimize coverage on the off-day turn shifts and weekends. It is estimated that the afternoon and midnight shifts and the weekends will be covered by approximately 19 operations personnel at all times. The quality of working conditions could be improved with innovative scheduling, such as 4-day weeks or 12-hour schedules. This approach could also reduce the employee's cost and frequency of commuting to Deer Island. It is recommended that an organization of concept be adopted, that many of the systems be put in place, and that personnel placement be completed before the end of 1991, along with the scheduling and salary planning needed to prepare for the construction period and the new facilities start-up.

Staff Placement

The proper placement of staff in the required positions at the proper time is also a critical issue in staffing the organization of the Deer Island treatment facility. The phased construction program places a heavy demand on the management staff for existing personnel to be in place and properly trained in a continuing effort to meet the required effluent limits during this period. This process must start immediately so that the existing staff can be

placed and trained to handle the ongoing process requirements while new staff are being hired, trained and placed, before the new primary disinfection and residual facilities are brought online. It is expected that a minimum of 150 existing personnel and 150 new people will be trained before the end of 1995. The remaining 130 personnel must be hired and trained before mid-1999. This is a tremendous task to be accomplished within the scheduled time frame.

Treatment Plant Control Strategy

The large numbers of staff, and the variety of their skill requirements, that are necessary at Deer Island require that considerable thought be given to how the facilities are going to be effectively controlled when operational. The control process depends on two distinctly different systems (i.e., a personnel system and an operations system) that integrate the work of the four sections to accomplish the mission of effective pollution control.

Control of Personnel

The control of personnel to effectively blend numerous skills and personalities starts with an understanding on the part of each individual of what his position assignment is intended to accomplish in the total structure of the organization. The direction of the staff centers on the management team which is indicated on Figure 11.5.1-1. It is intended in the prototype organization that the Superintendent will not get involved in every detail of operation, but will delegate responsibility to the four section managers. The Superintendent receives information required for review of results, for decision-making and for directing the section managers from the Data Manager and the four section managers. By utilizing this approach, the Superintendent can view the overall picture of accomplishments, needs and direction of the organization and provide guidance to the section managers to resolve or address problems related to their assigned section that impact the overall achievements of the plant. The four section managers manage their respective organizations in the same manner by utilizing and directing the supervisors, assistant managers and foremen assigned to them. The prototype organization was structured to ensure that no assistant manager's span of control will be greater than 6 supervisory personnel. This provides effective management and supervisory input to the operation of the sections. Each of the four sections was provided a position within the section to furnish to the supervisory staff the information needed to make the decisions required by their position in the organization. Clerical assistance to all sections will be provided by the Clerical Unit within the Administration Section and controlled by the Principal Clerk.

The Assistant Managers provide the direction of the sections through the supervisory teams identified in Figure 11.5.1-1. In turn, the supervisory personnel control the detailed tasks of the assigned staff teams in each of the sections. Again, the span of control was restricted for each supervisory position to a specified number of personnel and equipment area responsibilities to ensure successful achievement of the assigned responsibilities.

Control of Operations Systems

Each of the four sections encompasses tasks that are both interrelated to each other and unique to their section. An example is that the primary focus of successful fulfillment of the Authority's mission is on the Operations Section; however, the other three sections must perform their roles successfully for the Operations Section to achieve its goals. The other three sections must be viewed as support services for the Operations Section. This direction will be accomplished by the development of detailed management systems as discussed in Section 11.5.2 of this plan. As an example, the process control management system (PCS) details how the treatment process will be controlled, by whom it will be controlled, and what input is required from others (such as laboratory results of process sampling and analysis). These systems become critical in a large complex system staffed with numerous people and sprawled over a large area. They also provide accountability for individual unit process performance and the personnel assigned to that process area. This management system, in conjunction with the MIS, the sampling and analysis plan (SAP), and the maintenance management system (MMS) defines the needed flow of information, the proper sampling and analysis information and equipment reliability to properly achieve the required results. These systems and the utilization of an interactive and networked computer system will assist in holding the various operating functions together. The Operations Section is also divided into five manageable units (Headworks, Pump & Power, Primary Treatment, Secondary Treatment and Residuals). The organizational chart for the Operations Section is also structured to correspond to these process units (see Appendix G). The physical control of the Operations Section focuses on operation control centers connected by a distributive digital control and central information system. The process will be controlled by the process control personnel located in the operations management center in the Administration Building. Information on operations, security, maintenance and laboratory will go to the operations management center before distribution to the four main control centers located in the Primary, Secondary, Pumping and Power, and Residuals areas of the facilities. Overall plant operating decisions will be made at the operations management level with implementation being carried out from the four main control centers.

The Data Manager in the Superintendent's Office, in addition to providing information to the management team, coordinates the flow of information throughout the computerized management information system (MIS). "Needs to know" information will be identified for use by each manager and supervisor as needed to properly perform their duties; and through the computer system, this data will be provided to the proper location for effective control of an assigned area. The Data Manager is supported throughout the organization by a number of clerks (Administrative Data Entry, Laboratory Data Technician, Maintenance Stores Clerk, Scheduling Clerks and Operations Process Technicians) who input the identified and required information into the system for use. All status reports, executive summary reports and required regulatory reports will be computer-generated from the MIS.

The maintenance control strategy will focus on the computerized MIS and will address all maintenance requirements including preventive and corrective maintenance. The computerized MIS will provide a list of all equipment in the system, an equipment numbering system, detailed

equipment information, the preventive maintenance (PM) program, the lubrication program, a work order system to assign and track work completion, an equipment maintenance record system, a storeroom inventory system for parts, tools and supplies, supported by a purchasing system to replenish inventory depleted. Requests for corrective maintenance will be written by any employee, submitted to a supervisor for verification and clarification and submitted to the Scheduling/Planning Group in the Maintenance Section for input into the system. This group will schedule the work, the personnel needs, parts, supplies, or tools needed, print a computerized work order form detailing the information required, and give the forms to the appropriate assistant maintenance manager for review and assignment to a foreman in charge of the maintenance team that will do the work. The form will be returned by the same route back to the Scheduling/Planning Group for completion notice to operations, input to the record system and removed from the routing.

This maintenance system and all of the maintenance personnel, shops and main storeroom will be located in the Maintenance Control Center Building.

The Administration Section will be located in the Administration Building and provide support to all sections including clerical, personnel, first aid, financial, safety, fire protection and transportation, and security teams. Requests for administrative services must be approved by supervisory and assistant management personnel to minimize unnecessary requests of these groups.

Two special groups have also been organized within the structure of the Administration Section. They are: (1) Transportation and Security, and (2) Safety and Fire Protection.

The transportation issues arising from the movement of many people each day to Deer Island for work and deliveries of supplies, materials, and chemicals will require considerable coordination. As a result of restricted traffic flow through Winthrop, most of the traffic will come through the Deer Island dock area by barge. The security of the facility will also be controlled from the two entrance points (Winthrop and the dock). Security forces may be provided by MWRA staff or by an outside private contractor 24 hours per day/7 days per week. Both the transportation and security functions will be coordinated and directed by the Transportation and Security Unit within the Administration Section.

The Safety and Fire Protection Unit, also established within the Administration Section, will coordinate and direct these activities. It is intended that the safety personnel will define, outline, and be responsible for the implementation of the Deer Island safety program through coordination with outside vendors and the Deer Island Training Unit.

A Fire Chief position has been recommended which will organize a volunteer fire unit in the Deer Island Plant, including personnel and equipment. This unit will be trained in firefighting and the handling of major chemical spills. The position will also establish and coordinate cooperative agreeements with the Town of Winthrop and the City of Boston to assist in major incidents that might occur.

The Laboratory Section is also a support section for the operation of the facilities. They will coordinate and schedule all sampling and perform analysis for process control and permit requirements. The laboratory will be located in the Operations Management Building.

### 11.5.2 TRAINING AND STAFF DEVELOPMENT

Introduction

The best-planned, designed and constructed wastewater facilities will not perform properly unless staffed with qualified, adequately compensated, dedicated and appropriately trained personnel. These standards must be addressed through an effective personnel recruitment and retention strategy. An effective recruitment program must address the issues necessary to attract well qualified and trainable personnel. Some of the issues that are important in recruitment of personnel for the Deer Island treatment facility include:

- o Identification of the qualifications that address the skill requirements of all the positions in the organization chart;
- o Pay scales and benefit packages that will attract qualified and skilled applicants;
- o Identification and resolution of alternatives that address the problem of commuting to the Deer Island site;
- o Identification and publicizing of the opportunities for advancement within the organization;
- o Developing an awareness of interesting work and career opportunities at the Deer Island plant;
- o Providing entry-level training and certification opportunities for newly recruited personnel; and
- o Identification and preparation of a procurement strategy that will address the four hundred new hires required to staff the Deer Island facilities in the year 1999.

The intricacies of the new Deer Island Wastewater Treatment Plant, including the four remote headworks, are coupled with some additional problems unique to these facilities such as: the Boston Harbor location, commuting problems, competition for skilled labor, and the area's economic considerations including the high cost of living. Such factors compound the issues of staff procurement and development. These questions and the need to address their solutions require an organized approach that will culminate in the staff being prepared to manage, operate and maintain the facilities that are existing and those that will be placed in operation in 1993-1995 (primary treatment) as well as, ultimately, the secondary facilities in 1999. A well-thought-out recruiting plan, in conjunction with competitive compensation and

attention to the provision of special transportation and scheduling accommodations for hired workers, should alleviate the unusual stresses mentioned above and aid in the attainment of this goal.

These issues must be addressed and resolved so that operations and maintenance staff will be in place for the start-up of primary treatment facilities in 1995 and for the start-up of the secondary facilities in 1999. A suggested procedure includes:

1. Adoption of an organizational structure for management/operation of the new facilities.

2. Preparation of complete position descriptions, including duties and qualifications, for each position in the organizational structure.

3. Adoption of competitive salary schedules and benefit packages per position and grade.

4. Determination of staffing needs for start-up and operation of the phased facilities.

5. Development of programs to train the staff to operate the new facilities.

6. Procurement and placement of staff. (This includes a review of qualifications and placement of the existing staff into the new organizational structure, and the hiring of new personnel.)

7. Training of personnel, phased as required to meet the needs of the new facilities.

8. Establishment of special or innovative provisions in the areas of transportation, shift scheduling, unusual circumstances related to employment at the facility.

Training

Recruitment and Placement

The prototype organization, as discussed in Section 11.5.1, is demonstrated through the use of functional tables of organization and organizational charts included in Appendix G. It is recommended that an organizational structure be adopted by the Authority so that the position descriptions can be prepared, the salary structure prepared and adopted, and the screening and placement of existing personnel begin.

The actual recruitment procedure must begin after the organizational structure, position descriptions and salary and benefits are prepared and adopted by the Authority. This procedure must focus on obtaining local people and training them to fulfill the new job requirements. Recruitment of personnel with existing wastewater skills will be very limited because of the lack of such people within commuting distance of the facilities. Some personnel from outside the Boston recruiting area who have skills and experience in the wastewater treatment field should be hired for the management/supervisory positions. The general direction of the

recruitment effort will be to place some experienced personnel in management/supervisory positions, and to advertise heavily in the trade journals, periodicals and local newspapers to attract interested applicants. The advertisements should emphasize the skills required for each position. The Authority's Personnel Department should determine staffing needs (numbers of people, skills, etc.) before the advertising part of the program begins. When the applications are received, an initial screening by the Personnel Department staff should be performed. This screening should focus on the (1) application received; (2) resume, if applicable; (3) work history; (4) work references; and (5) apparent reliability in work history. Based on the initial screening, the application should be matched to a skill level in one of the four sections in the organization, or rejected.

If the applicant can be matched, an interview should be conducted by a minimum of three Authority personnel (1 member of the Personnel Department, 1 from plant management, and 1 supervisor in the applicant's skill area). The interview should review and seek more detail in the applicant's interest in working at Deer Island, interest and willingness to be trained and to attend training sessions, and additional detailed information regarding skills, work history and references, if any.

It is recommended that all new applicants be tested, if possible, by the State Employment Service or by an outside contractor for aptitude and ability in reading, as well as the ability to perform basic mathematics and mechanical aptitude. Some positions in the organization require that applicants should be tested for their ability to write clearly.

The applicants are then ready for placement in a position compatible with their skills, based on the information gathered during the screening, interview and testing process. The decision on whether and where to place should be made in a meeting of the three interviewers. When the decision is made, the applicant should be informed of the decision in writing, detailing starting salary, benefits, report date, orientation procedure and initial training assignment.

The orientation of all employees should be thorough and should be required before the employee starts specific position training. The orientation should include: (1) the mission of the organization; (2) policies, procedures, and benefits; (3) where the assignment fits into the organization; (4) importance of the assignment; (5) importance of the training program; and (6) where to go with immediate questions that may come up during the orientation period.

The last step of the recruitment procedure is the assignment of employees to the training program specific to their position placement. It is recommended that the training program and salary structure be configured to encourage personnel to become more skilled in their position assignments through a combination of specific training programs, including off-site offerings, apprentice programs, management programs, and the passing of certification tests and other skill examinations that show competence in their assigned work areas. This program should be structured with built-in salary increases that are based on the successful completion of the specific training. This approach bases the employees' advancement on the initiative to become more qualified in the wastewater treatment field, and on the improvement of their job skills.

Certification Requirements

The end result of good training and a good job attitude on the part of the employees assigned to the Operations Section should be to become a certified wastewater treatment plant operator in the Commonwealth of Massachusetts. The state requires that the person in charge of the Operations Section, the assistant managers, and the shift supervisors in charge of the off-shifts be certified as Class VII Operators, which is the highest classification. Many of the other positions, such as unit foreman, should be required by the Authority to obtain certification at a lower level as a condition of holding those positions. Other levels down to Class I certification should be placed on the merit system of training and certification required to achieve salary increases.

Ultimately, when the secondary treatment facilities go online in 1999, there will be approximately 207 people in the Operations Section responsible for operating the facilities. State requirements for certification as of this time require 11 Class VII personnel (the operations manager, the five assistant managers, and the five shift supervisors). These are the only required certified personnel; but as recommended, the certification levels should be built into the training and salary program to ensure advancement and the presence of trained, qualified Operations personnel at all levels.

The general approach to building the organization will be to use existing staff that meet position qualifications to develop a "core group" of qualified personnel who will provide a nucleus around which the complete organization can be built. The addition of the new personnel and preparation of amplified management systems described later in this section will expand the staff and its capabilities as the new facilities grow and treatment requirements increase.

Analysis of the Training Process

Training is the most important tool available to the Authority to protect its capital investment and provide optimum operational efficiency. A successful training program in a wastewater organization encompasses many facets of employee development that are essential for maintaining a skilled and responsible staff. While training must provide both general and specific training in the wastewater system's equipment and control, an attempt must be made throughout the program to build a general interest in the wastewater profession and a desire to "make it work". The training program must stress the interrelationships among jobs, departments and processes at the facilities, and the impact of a job well done (or poorly done) on the health and welfare of the community and the surrounding environment.

The instructors must be knowledgeable and experienced and make every attempt to provide a relaxed training atmosphere, where questions can be asked and problems and situations discussed freely. Feedback from the trainees is an effective measure of the progress and efficiency of the training and allows clarification and emphasis to be placed on critical points.

Based on current training available in the Boston area, the complexity and size of the new facilities, the non-availability of like facilities in the Boston area for a supply of

experienced personnel and other problems unique to Deer Island, the Authority will be severely limited in obtaining people for the provision of effective training to the existing and newly-hired staff. The numbers of total personnel in the prototype organization of approximately 550 people, of which over 300 will be new hires, will create a demand on the local labor market if the present low unemployment rate remains stable. This will probably result in a young staff either just out of high school or technical school, or with less than a college degree and no experience in wastewater treatment. This will also be true of older potential employees and will result in the need for an extensive training program that must be organized and presented by the Authority. The program, again as a result of the type and numbers of people involved, must be extensive, site-specific, thorough and job-related in order to be effective and meet the needs of the Authority. Based on this analysis, an on-site training program should be set up and tailored specifically to the Authority's requirements.

Training Needs and Program

The training of personnel must be prepared and presented relative to three major considerations:

1. The section of assignment (i.e., operations, maintenance, administration or laboratory);
2. The unit of assignment within employee's section (i.e., management, supervisory or staff); and
3. The experience level of the employee.

The treatment plant is organized into four sections: Administration, Operations, Maintenance, and Laboratory, as previously discussed. Each of these sections has a specific role to achieve in the effective operation of the plant, but all are interrelated and each is dependent on the other. In general, the sections of administration, laboratory and maintenance are service sections that support the operations section. Training must tie these sections together functionally by providing precise understanding of the function of a particular section and also providing an understanding of the purposes of the other sections. To accomplish this, the training effort should be divided into six distinct areas:

1. Management
2. Supervisory
3. Operations
4. Maintenance
5. Laboratory
6. Administration

Each of these areas should receive instruction on specific topics, some of which are listed by area, as follows:

The management team should receive specific instructions on (1) management fundamentals including such topics as planning, directing, delegation, evaluation of programs and employee

performance, negotiations and an approach to utilizing human resources including administering praise and reprimands; and (2) facility-specific management systems.

The supervisory team includes all second-level management personnel such as assistant managers, directors, supervisors and foremen. Their training should include such topics as (1) facility-specific management systems; (2) supervisory fundamentals in planning, directing, delegation, evaluation of results and employee performance; (3) all operations training topics; (4) all maintenance training topics that are applicable to their area of responsibility; and (5) safety.

The Operations personnel would receive instruction specific to their responsibilities. It is important that they receive both a broad understanding of the total facility and specific instruction on the individual unit processes. Some of these topics include (1) theory of wastewater treatment (general); (2) specific instruction utilizing the previously prepared O&M manuals and unit process standard operating procedures (SOPs); (3) selected facility-specific management systems; (4) objectives of plant operations and the mission of the facilities; (5) proper sampling techniques; and (6) safety.

The Maintenance division personnel would receive their training throughout the start-up and debugging phases of the program. Specific topics should include (1) selected facility-specific management systems with emphasis on the maintenance management system (MMS) and the maintenance department role; (2) hands-on instruction coordinated with the equipment suppliers' startup and training requirements on such equipment as pumps, bearing replacement, proper pump packing techniques, proper lubrication procedures, rigging, how to perform proper preventive maintenance, safety and other topics related to maintenance.

The laboratory employees' training is based on the service they provide to support effective process control. Specific topics should include (1) selected facility management systems with emphasis on the sampling and analysis plan (SAP); (2) sampling procedures and techniques; (3) laboratory data management (part of the facility-wide management information system [MIS]); (4) all operations division topics; (5) specific laboratory analysis procedures; (6) laboratory QC/QA procedures and programs; and (7) safety.

The Administration division personnel would receive training specific to their individual assignments as required. In addition to improving their over all understanding of process as a service function to the facilities, training would include (1) selected facility-specific management systems; (2) roles of the various sections; and (3) roles of the various units within their section.

As outlined above, the four divisions will each receive a different type of training; however, there should be some information passed through the program to provide knowledge to all employees regarding the functions of each division and their roles in the mission of the complex, i.e.:

1. Present Operations personnel must operate the existing facilities until the new primary

facilities are constructed and fully operational. This group, plus any needed new employees, would receive training to operate the new primary and residual facilities when they come online in 1995. This expanded group will become the key personnel for the new secondary and expanded residual facilities scheduled to begin operating in 1999, and will be appropriately trained. New employees being added to the staff prior to the completion of the 1999 facilities would be trained to operate all the new primary, secondary and residuals processes before being placed in the facilities to perform duties.

It is expected that each member of the operating staff would receive a minimum of sixty hours of a combination of classroom and hands-on training.

Training Program Preparation

The final training program should be outlined. The topics required to assure effective control of the plant must be identified, and topics necessary to update existing staff and to aid in the actual preparation of lesson plans, O&M manuals, standard operating and maintenance procedures, and other written products that support the program should be completed before training is started. The training should be supported by a variety of visual aids. The use of slides and flip charts are "old standard" techniques that still have value during the training of personnel; however, video tapes on in any topics, including operations, maintenance and management and supervision, are now used extensively. Other tapes could be made specifically on-site to provide site-specific information on selected topics. Another tool that should be considered is the preparation of interactive audio/visual programs, on discs, which cover very specific subjects in great detail. These programs should be viewed frequently by the trainee to maintain a high operational standard. This type of training visual aid is being used in many manufacturing facilities to assure accuracy and consistency in operational or maintenance procedures. The O&M manuals must be completed before the training program begins, and be prepared in a format and in sufficient detail to provide a textbook for the operation, maintenance and management of the facilities. The manual should be completed as a series of mini-manuals, each standing alone and covering the areas of operations, maintenance and management. The operations manual should be further divided into mini-manuals covering each unit process controlled by an operations control center. The maintenance manual should also be divided to cover the Maintenance Management System (MMS) and the storeroom area.

Training Available in New England

In cooperation with the New England Joint Training Coordinating Committee (NEJTCC), an organization involved in the development, planning and implementation of training programs for environmental systems operators, a survey was conducted of all training courses offered in New England over the past three years. This survey covered the states of Massachusetts, New Hampshire, Maine, Connecticut, Rhode Island and Vermont.

The results of the survey showed that out of the eighty-five course offerings for environmental systems operators in 1987, twenty-three of them were located in Massachusetts and only eight of

these were in the field of wastewater treatment. These eight courses were conducted at the Massachusetts Bay Community College in Wellesley; the University of Lowell; the Amherst, Massachusetts wastewater treatment plant; and five other locations offered by the training center operated by the Massachusetts DEQE.

At this time, most of the training is delivered during a one-day seminar and is limited to basic wastewater treatment including chlorination, or certification review. No other courses are known to be offered including adult education programs in local high schools or vocational technical schools.

Training Alternatives

The approach to training a large staff, such as the one that the Deer Island Wastewater Treatment Complex will ultimately have, presents some unique problems. The actual training could take place according to any one of three location options:

1. On-site at Deer Island;
2. Off-site at a location convenient to the majority of the students;
3. Or a combination of the two.

The training available under any of the location plans would be similar. The off-site instruction would be hampered by the inability to perform hands-on training using the equipment and facility that the student will eventually work with. It is extremely important to the majority of the trainees that they receive both classroom and hands-on on-site training. The use of facilities other than Deer Island would be extremely limiting to the training program because of the type of treatment taking place at, and the size and location of, the Deer Island Treatment Plant.

The on-site training could be completed following one of three approaches:

1. An outside contractor could perform the training program, and the treatment plant training staff could participate as a part of the contractor team. This approach would provide a learning experience for the plant training staff in the preparation of training materials, lesson plans, visual aids, instruction and organization of future programs. The staff could also provide evaluation of both the instructors and trainees to ensure that effective training is carried out.

2. An outside contractor could provide the training alone. The contractor would set up the temporary training center; prepare the materials; provide instruction, both classroom and hands-on; and provide an evaluation system.

3. The Authority's staff could provide the training alone. The staff would perform the complete program described above.

The three training options listed above could be performed off-site, but would be complicated by the absence of the equipment and facilities for hands-on training. It is possible to establish a training center in a conveniently located community college, a university, or a vocational or high school that participates in adult education programs, but the site and installed equipment would not be available to the instructors or the students for hands-on training and familiarization.

Recommended Approach

The recommended approach is based on the suggestion that all training, with the possible exception of some of the administration and laboratory training, will be performed on-site. The program should be developed, prepared, presented and reinforced based on the equipment and facilities being placed into operation both in 1993-1995 and in 1999. Both programs would be started about 6 months before the start-up date of the facility. As a result of the construction completion schedule, the program will be presented twice with major expansion, enlargement and reinforcement to cover the complete facility in 1999. It is suggested that both programs be conducted according to a phased approach, incorporating the following elements:

Phase I

Areas requiring special attention during this phase are management and supervisory training. Heavy emphasis should also be placed on the development and delivery of a maintenance training program. This program should begin as soon as the prototype organization is established and key managers and supervisors are in place. The program should be repeated 10 months prior to the 1995 and 1999 start-up dates.
All other training programs should be developed for the primary plant during this phase.

It is also recommended that a pretest for all existing facility personnel be conducted immediately after adoption of the prototype organization. The pretest is very important because the programs and lessons that will be prepared for upgrade training will be tailored to individual employee strengths and weaknesses. The pretest will also assist the Authority in staff placement and in determining its hiring needs.

The evaluation protocol for all training should be established and put in place to ensure the successful completion of the program.

Phase II

In this phase, all prestart-up classroom-type training will be given to the existing staff and new employees. Familiarization with the facilities and the equipment should also be developed. This phase would begin approximately four months prior to start-up and would be completed within 60 days.

Phase III

All hands-on training timed to coincide with the actual start-up of the equipment will be completed in this phase. This phase must begin about 60 days prior to start-up and be completed within 90 days (30 days after start-up).

Phase IV

Reinforcement of the previous training based on start-up and operating experience at the facilities should be initiated as needed about 120 days after start-up and be completed within 45 days.

Phase V

A second reinforcement training period should be initiated about 270 days after the start-up and be completed within 60 days.

The issue of procuring staff, and the development and training of staff in a facility this large and complex, must also follow a well-defined procedure within the above phases to ensure that all elements and personnel are in place when required. The specific steps of this procedure will be included when the detailed Plan of Operation is prepared during the design phase of the project. Some of these steps were discussed previously, but are repeated and included here to show the complete procedures and to emphasize their importance. The suggested procedure includes the following:

1. The organizational structure must be adopted by management as the arrangement necessary to accomplish the mission of the facilities complex and provide direction for staff development and training.

2. For each position shown on the organizational chart, a position description that lists the types of duties that must be performed, and the qualifications required of the person filling the position, must be prepared.

3. Salary schedules and benefit packages that provide adequate compensation for the duties performed by each position shown on the organizational chart must be prepared and adopted. When establishing salaries at the Deer Island Plant, considerations should include:

   (a) pay for like positions in other, similar facilities;
   (b) Boston economic climate;
   (c) required position qualifications including certification; and
   (d) incentives to attract employees to make the commute to the Deer Island Plant.

4. Staffing needs must be determined for the existing facility, the phased operations and the final facility's start-up and operations as discussed and illustrated previously in this section of the facilities plan.

5. The development and preparation of training programs and materials must be completed before the placement of the staff in the prototype organization of the facility is begun. These programs and materials will be prepared for two different groups of students (existing and new hires) and should cover the tasks identified in the various position descriptions. The students will fall into one of two training groups:

   (a) Existing staff working in the present facilities who will be placed in a position on the new prototype organizational chart, based on their qualifications, and will receive upgrade training. This part of the training program will include the various operations and maintenance functions, installed equipment, policies and management systems for both the existing and new facilities.

   (b) New staff procured and placed, as defined earlier in this section of the report, into vacant positions in the organizational structure. This group will receive entry-level training on the functions of the facility, equipment, policies and management systems similar to the training received by the above group.

   Training materials must be procured and/or prepared to support the training programs. The programs will be outlined and topics identified for each of the sections in the organizational structure including:

   - o Operations
   - o Maintenance
   - o Administration
   - o Laboratory.

   The program will be broken down further to define specific topics, both those that are common to all sections and those that are specific to each section, such as:

   - o Management Training
   - o Supervisory Training
   - o Treatment Overview and Theory
   - o Process Control
   - o Maintenance Training
   - o Administrative Procedures
   - o Sampling Procedures
   - o Authority Policies
   - o Management Systems

   The preparation of policies and procedures, to provide the foundation for personnel

stability and for use in the training program, are an essential element in the proper training of the Deer Island Plant personnel. A good example would be a Personnel Policy Manual. This manual should answer most qustions that the staff may raise regarding working conditions, benefits, timekeeping, records, etc., and provide continuity for handling other personnel matters for management and supervisory teams as they carry out the task of staff development.

Management systems, in addition to the policy manual, will provide a concerted effort to establish stability and direction for meeting the goals of the facilities. These systems should be developed along with the personnel policy manual. These systems can cover many items; a few of the most important follow:

(a) Process Control System (PCS) that designates those responsible for making process control decisions; those who should be informed of these decisions; personnel making the process changes; parameters that are required to be met by each individual unit process; and who will be held accountable for proper performance of the unit processes.

(b) Maintenance Management System (MMS) that includes a master list of equipment included in the system; an equipment numbering system; a communications system that notifies the maintenance division of the need for maintenance; a work order system; a preventive maintenance program including a lubrication program; and an inventory system, providing parts and supplies, that supports the proper maintenance of the equipment, buildings, grounds and vehicles.

(c) A Management Information System (MIS) that identifies what "needs-to-know" information will be received by whom in the organization and when it must be available for that person to effectively perform his/her job.

(d) Sampling and Analysis Plan (SAP) that identifies the sample points; size and type of sample; sampler size; frequency of sampling; analysis for each sample point; and other related information.

(e) Data Management System (DMS) that indicates information to be recorded; who will record it; who will receive it; what kinds of reports will be generated; and what these reports will contain. In general, this system will establish the flow of information throughout the organization, based on what different areas and/or people need to know in order to do their jobs.

(f) Emergency Operations Plan (EOP) - this system will establish the vulnerability of different equipment, processes and areas of the plant in emergency situations and what the nature of those situations might be. It should describe the actions that must be taken in a number of different types of emergency situations and should establish whose responsibility it is to react to them.

These systems and procedures should be prepared under a contract with a consultant who has experienced operations and maintenance personnel on his staff. The Deer Island facilities management staff should also be involved in the preparation and review of systems and procedures to ensure understanding and proper use when the facilities are placed in operation.

6. A review of the qualifications of all existing personnel, using the new prototype organizational charts and position descriptions as guidance, must be made in preparation for the actual placement of staff to operate and maintain the new facilities. The results of this review will be to place personnel into the new organizational structure in the positions in which they have the greatest opportunity to succeed, based on their qualifications. These personnel will be trained based on their past experience and according to the requirements of the positions they will occupy in the new facilities. This group should provide the foundation and stability for staff development and facility performance required until newly-hired personnel can be placed, trained and have the opportunity to acquire some experience.

   It is suggested that new personnel required to maintain the needed staffing levels also be hired and placed into the vacant positions in the new organizational chart at this point in the program. Each new employee will receive appropriate training before being placed in the facility for duty.

7. The last step of this procedure will be the actual presentation of the training program to all personnel as outlined and prepared previously. The training must include both classroom and hands-on training to be effective and to impact the actual operation and control of the facility.

Role of Construction Manager and Lead Engineer

A project of the size and scope of this project will have both a Construction Manager who will coordinate and direct all construction activities including equipment installation and testing by equipment vendors, and a Lead Engineer who will coordinate all activities including construction engineering and continuing facility operations during the entire project. Both of these functions must include interfacing and assistance with the total training package. The classroom and hands-on training performed by the training contractor uses and coordinates into its program the training received from equipment suppliers and other vendors during the construction process. This training is particularly valuable to the operations and maintenance staff's first-hand understanding of the new equipment being installed.

The Lead Engineer assists in coordinating all of these activities. Particular attention must be paid to maintaining the operation and maintenance of the existing facilities while the new facilities are being constructed. This presents excellent training opportunities to help both new and existing personnel understand the process equipment during the manipulation of the facilities during this period.

This training can also be enhanced by involving the facility's supervisory staff during the construction prestart-up, start-up, and debugging of the facilities. Key supervisory staff should be hired during the design phase of the project so that they can participate in the design and construction process. Effective training is provided to supervisory personnel when they are included in the design review process and the construction phase. It is recommended that the electrical and mechanical supervisors become assistant inspectors to the construction inspectors hired by the construction management contractor.

Training Program Size and Estimated Costs

This training program, driven by the need for immediate upgraded training of the existing staff (about 200 people), the numbers of new staff required before 1995 (about 225 more), and the additional changes and staff required in 1999 (about 350 above present levels), is probably the largest wastewater treatment plant training program that will be undertaken in the next 10 to 12 years in the United States. The location of the facilities, in conjunction with the other factors impacting the training program, calls for the actual approach to and implementation of this project to be different and somewhat innovative. The construction program being performed on a site of limited size will dictate the necessity of establishing a temporary training facility on the site by using mobile-home-type units fit together and sized to provide the contractor with preparation space and classrooms for actual instruction.

Based on training experiences in other facilities, and incorporating an escalation of the costs of those programs to present-day numbers, it is estimated that this training program for some 540 people will cost between $10 and $12 million dollars. The cost includes all expenses including temporary classrooms, contractors' offices, material preparation, instructors and other miscellaneous expenses.

### 11.5.3 PRELIMINARY OPERATIONS PLAN

Construction grant funding requirements necessitate the preparation of a plan of operations during the design and construction of treatment facilities. The plan is intended to identify those steps required for cost-effective, efficient, and reliable start-up and continued successful operation of the treatment facilities. The plan provides a concise description and implementation schedule, compiled in chronological order, of the major items required to ensure a successful start-up and operation. (See Table 11.5.3-1)

Items addressed in the plan of operation are proposed O&M budgets, including provisions for salaries and benefits to attract qualified personnel to run the proposed facilities; a financial management system; a staffing and staff training plan; an emergency operations program; development of a maintenance management system; start-up schedules and procedures; preparation of O&M manuals; and the development of an operations and maintenance program coordinating all of the O&M activities of the new and existing wastewater treatment facilities. Procedures and formats for reporting laboratory results, treatment plant performance, and general recordkeeping are also addressed.

TABLE 11.5.3-1

DEER ISLAND WASTEWATER TREATMENT COMPLEX
PRELIMINARY PLAN OF OPERATION

| Task | Estimated Start | Estimated Completion | Responsible | Completed By |
|---|---|---|---|---|
| Prepare Preliminary Plan of Operations | 2/88 | 6/88 | MWRA | Consultant |
| Final Plan of Operation | | | | |
| o Primary | 10/83 | 6/94 | MWRA | Consultant |
| o Secondary | 6/98 | 10/98 | MWRA | Consultant |
| 1. Staffing | 6/88 | 5/89 | MWRA | Consultant |
| o Needs | 6/88 | 10/88 | Consultant | Consultant |
| o Prepare Table of Organization | 7/88 | 11/88 | Consultant | Consultant |
| o Prepare Position Descriptions | 9/88 | 2/89 | Consultant | Consultant |
| o MWRA Approval | 2/89 | 4/89 | MWRA | Client Dependent |
| o Prepare Salary Schedule | 12/88 | 4/89 | MWRA/ | Consultant Consultant |
| o Prepare Benefits Package | 12/88 | 4/89 | MWRA/ | Consultant Consultant |
| o Prepare Hiring Schedule | 2/89 | 4/89 | Consultant | Consultant |
| o MWRA Approval | 4/89 | 5/89 | MWRA | Client Dependent |
| 2. Training (Primary Plant) | 5/94 | 12/95 | | |
| o Develop Outlines | 5/94 | 12/94 | Consultant | Consultant |
| o Submit to EPA and State Training Schedule | 1/95 | 2/95 | Consultant | Consultant |
| o Develop Lesson Plans and Visual Aids | 10/94 | 5/95 | Consultant | Consultant |
| o Implement | 5/95 | 12/95 | Consultant | Consultant |
| o Coordinate Manufacturer's Training | 5/95 | 12/95 | Consultant | Consultant |

**TABLE 11.5.3-1**

**DEER ISLAND WASTEWATER TREATMENT COMPLEX**
**PRELIMINARY PLAN OF OPERATION**
**(Continued)**

| | Task | Start | Estimated Completion | Estimated Responsible | Completed By |
|---|---|---|---|---|---|
| 3. | Records, Reports and Laboratory Control (details omitted) | 5/95 | 8/95 | Consultant | Consultant |
| 4. | Process Control and Startup Activities (details omitted) | 6/95 | 12/95 | Consultant | Consultant |
| 5. | Emergency Response Plan (details omitted) | 3/88 | 12/88 | Consultant | Consultant |
| 6. | Maintenance Management System (details omitted) | 5/87 | 3/88 | Consultant | Consultant |
| 7. | Operations and Maintenance Manuals (details omitted) | 1/94 | 6/95 | Consultant | Consultant |
| 8. | Operations and Maintenance Budget (details omitted) | 1/92 | 9/92 | MWRA | MWRA |
| 9. | Ordinances, Permits & Industrial Wastes Program (details omitted) | 1/87 | 10/88 | MWRA | Consultant |
| 10. | Safety Program (details omitted) | 2/88 | 1/89 | MWRA | Consultant |
| 11. | Septage Receiving (details omitted) | 3/88 | 10/88 | MWRA | Consultant |

The actual plan of operation is prepared in two steps. A preliminary plan is prepared during the design phase and presents a schedule of required events in terms of the number of days prior to the initiation of operations. A final plan is prepared during construction and must be completed prior to the mid-point of construction activities. The final plan details dates for the completion of tasks within the plan along with detailed information pertaining to identification of personnel who will perform various tasks within the plan.

A conceptual plan of operation, addressing items which will ultimately be detailed in the preliminary and final plan of operations during the design and construction phases of the project, was prepared as part of this facilities plan. The conceptual plan identifies items related to staff development which must be addressed during the period leading to actual construction of the recommended treatment facilities, and describes how these issues tie into the general start-up of the facilities. This will assist in enabling the MWRA to anticipate staffing needs throughout the period leading to full operation of the recommended facilities.

The size of the proposed secondary treatment facilities will require the addition of significant numbers of staff and the operation and maintenance of facilities to which the existing staff is unaccustomed. Because of the importance of developing a quality staff for the operation of the recommended facilities and the difficulty anticipated in acquiring additional personnel due to the current lack of the required number of trained operators within the commuting area, the MWRA must begin to plan for the acquisition and training of this staff now.

The conceptual plan of operation includes critical items pertaining to staff acquisition and training, which must be completed in early phases of the project implementation, and follow-up activities related to the training of staff and the start-up of facilities.

Items pertaining to staff acquisition which must be addressed immediately by the Authority include the following:

1. Adoption of an organizational structure for management/operation of the new facilities.

2. Preparation of complete position descriptions, including duties and qualifications, for each position in the organizational structure.

3. Determination of staffing needs for start-up and operation of the phased facilities (by component based on construction scheduling - primary, secondary, etc).

4. Adoption of salary schedules and benefit packages per position and grade.

5. Development of programs to train staff to operate the new facilities.

These projects should be completed prior to the start of construction of the primary facilities in 1991. The procurement and placement of staff, including placement of existing staff into

the new organizational structure, should be performed in time to allow the phased training programs to proceed during the construction of the new facilities.

Other elements of the conceptual plan which will be implemented between 1991 and the start-up of the various facilities include:

1. Records, Reports and Laboratory Analysis

This portion of the plan calls for the identification and preparation of a variety of check lists, log sheets, records and report forms that the operations, maintenance and laboratory personnel must complete to assist in the proper monitoring and evaluation of processes and equipment.

2. Process Control and Start-Up Activities

Key to proper start-up will be the preparation of the Process Control Management System (PCS) that will identify responsibilities of MWRA personnel in controlling the effective operation of the facilities. The identification of personnel who will establish the proper process settings, use of equipment, process troubleshooting, debugging and optimization of the various unit processes is essential. Sampling and laboratory analysis, data interpretation and process changes will be optimized throughout the start-up and facility takeover period. Coordination of this element with the various equipment vendors' testing period is essential to ensure equipment reliability and continuity during the start-up period.

3. Emergency Response Plan (ERP)

It is essential that facility performance remain efficient at all times regardless of any emergency situation. It is important that this management system be developed to address all emergency conditions to ensure continuing facility operation with minimal disruption. Various emergency situations must be identified and contingency plans detailed for alternate methods of operation, emergency repairs, first aid, firefighting, and storm response before such situations arise.

4. Maintenance Management System (MMS)

This element sets up the MMS necessary to assure timely correction of equipment problems, and establishes a preventive maintenance and lubrication program to provide longevity and minimize equipment breakdowns, as well as a maintenance-needs communications system to provide for response to problems that do arise. The equipment maintenance responses must be supported by a record system that both provides necessary basic information on each equipment item and identifies the work that has previously been performed through the maintenance system. All of the maintenance must be supported by an effective storeroom containing sufficient inventory to accomplish all the required work in a timely fashion. This management system becomes the heart of the effective operation of the facilities by providing equipment reliability through the participation of all facility personnel. The planning of the system must be completed prior to

the installation and start-up of the equipment and its preparation must be scheduled so that it will be in place and workable prior to start-up.

5. Operation and Maintenance Manuals

These manuals must be prepared so that they can function as the textbook for the operation and maintenance training programs and as the reference manual for troubleshooting process problems. The information must be provided in a form that will help achieve and maintain high performance and efficiency levels at the facilities. These manuals are usually prepared with significant input from the design consultant, who has operation and maintenance staff with plant experience as a part of his team of designers; process consultants; and support groups such as electrical and instrumentation and construction managers who can help fit together meaningful information that provides long-term guidance to the facility operation and maintenance staff. These manuals should be prepared as a series of mini-manuals on the various unit processes, maintenance, sampling and analysis, personnel policies and other elements important to the successful performance of the facilities. The timing of their preparation is essential to the training program and the establishment of the various management systems needed to meet effluent compliance goals.

6. Operation and Maintenance Budget

An adequate income and budget must be provided to support the functions of the recommended treatment facilities. The budget should be well thought-out and should be in place in time to support the activities that will provide effective and timely preparation, start-up and continuing operation and maintenance of the facilities.

7. Safety Program

A detailed safety program should be in place in the existing facilities, but must be revised and upgraded to meet the requirements and numbers of personnel in the new Deer Island facilities. It is also important that the new program be prepared and in place before the training programs begin for the new facilities.

The elements of the conceptual plan of operation are summarized in Table 11.5.3-2. The elements are subdivided into events which should be completed prior to 1991 and those which can be completed during the construction and start-up of the primary treatment facilities. A similar sequence will be required for the secondary treatment facilities, to be constructed and started up during the 1995-1999 period.

## TABLE 11.5.3-2

## CONCEPTUAL PLAN OF OPERATION

| Task | Completion Date |
|---|---|
| Adopt organizational structure | |
| Prepare position descriptions | |
| Determine staffing needs | ----------1991 |
| Adopt salary schedules and benefit packages | |
| Develop training programs | |
| Procure and place staff | |
| Implement phased training programs | ----------1991 - 1995 |
| Records, reports and laboratory control | |
| Process control and Start-up activities | |
| Emergency response plan | |
| Maintenance management system | ----------1993 - 1995 |
| Operation and maintenance manuals | |
| Operation and maintenance budget | |
| Safety program | |

# Section 12

# 12.0 PUBLIC PARTICIPATION SUMMARY

## 12.1 INTRODUCTION

In facing the monumental tasks associated with the successful implementation of the Deer Island Secondary Treatment Facilities Plan (STFP), the Authority instituted a comprehensive public participation effort. The measures included in this summary were designed to meet federal and state regulatory requirements associated with the project, to satisfy grant conditions, and to provide the most meaningful avenues of public input into the critical decisions to be made by the Authority. Through this program, the Authority's dialogue with the public has been ongoing and important policy decisions have been made and will continue to be made within the context of maximum public knowledge and participation.

## 12.2 COORDINATION WITH OTHER HARBOR CLEAN-UP PROJECTS

Because the total Harbor clean-up program consists of many simultaneous efforts, the public participation activities associated with the STFP have been closely coordinated with public participation efforts being undertaken for other projects. Public participation coordination has mirrored similar efforts on the technical side, particularly with regard to overlapping concerns. Coordination occurs on several levels:

- Engineering and Public Affairs project staff and technical and public participation consultants for both the Deer Island Secondary Treatment Facilities Plan and Residuals Management Facilities Plan (RMFP) have met at least monthly to discuss coordination efforts and to review schedules and agendas for upcoming meetings.

- The public participation programs are coordinated through the Authority's Public Participation Coordinator and augmented by other Public Affairs staff, including media, intergovernmental and community relations personnel, particularly when project components have a direct bearing on a particular community.

- The Citizens' Advisory Committee (CAC) has served to review work associated with both the Secondary Treatment Facilities Plan and the Residuals Management Facilities Plan and have been kept informed of developments on other projects, such as water transportation, CSOs and the setting of local limits for industrial discharges.

## 12.3 CITIZENS' ADVISORY COMMITTEE

In July, 1986 the MEPA Unit of EOEA served notice of the formation of a Citizens' Advisory Committee for the STFP in the Environmental Monitor. In addition, notices were mailed to several hundred individuals and organizations and an announcement was placed in On the Waterfront, the MWRA newsletter, which was mailed to over 1500 individuals, groups and agencies.

Pursuant to discussions among agencies, it was decided that this CAC would serve to review both the STFP and the RMFP. Active members of the Authority's informal CAC from Phase I of the RMFP were solicited for nominations to the STFP CAC.

On October 10, 1986, EOEA Secretary James S. Hoyte appointed the CAC, which consists of 28 representatives and 15 alternate members as listed in Table 12.3-1. The CAC consists of representatives of environmental, business, community, government and other interests. In addition, agency representatives are serving in a non-voting capacity.

Technical support from Authority staff and consultants has been provided to assist in interpreting data and reports for the CAC. Administrative support from Authority Public Affairs staff and public participation subconsultants includes preparation of agendas, minutes and CAC reports, and scheduling of meetings and workshops. In addition, funds were allocated in the Authority's Capital Expenditure Budget to cover expenses the CAC may incur.

The CAC has met on a regular monthly basis and has chosen to form subcommittees to examine specific issues. In addition, a workshop on project scoping took place in February, 1986. The subcommittees have met on an as needed basis, generally on the fourth Monday of each month from 4:00 to 6:30 p.m. at a location agreeable to the majority of participants. Subcommittee meetings have been scheduled for the early part of each month as needed. Materials are distributed to the CAC at the end of the meeting for discussion at the following month's meeting. At times it has been necessary to distribute these materials through the mail, but sufficient time is allocated for the CAC members to review the information and prepare for the discussion. Agendas, minutes and certain other materials are also distributed prior to the CAC meetings.

## 12.4 TECHNICAL ADVISORY GROUP

As an adjunct to the public participation program, a technical advisory group has been formed to provide a mechanism for input from involved agencies as well as technical advice and support to the Citizens' Advisory Committee. Representatives of agencies involved in regulatory, permitting, funding or other capacities were solicited by the MEPA Unit of EOEA for membership on the TAG, as were former members of the siting EIS TAG formed under EPA's auspices. A list of those representatives is attached in Table 12.4-1.

In order to benefit from the Authority's presentations to the CAC and to assist the citizen representatives in understanding technical issues, TAG representatives are invited to attend all CAC meetings and workshops. They are provided with documents in advance of the meetings and are asked to provide written review and comment, to be returned to the Authority in a timely fashion.

With this arrangement, the Authority can benefit from the advice of the TAG without devoting large portions of the CAC's agenda to technical discussions which the citizen representatives may not understand. The TAG is also free to meet on its own or at the request of the agencies, such as the EPA.

## 12.5 PUBLIC MEETINGS

Public meetings fall into several categories:

A. Forums--In order to clarify the Authority's overall program for interested constituent groups and the public at-large, a forum was held in Boston in January, 1987. At this forum a total picture of the Harbor clean-up effort was presented. Two additional forums are planned for January and May of 1988.

B. Public Information Meetings--Public information meetings have been held at project milestones, including: Outfall Screening and Technology, in March at Lynn and Quincy; and Early Site Preparation, Alternative Site Layouts and recommended Inter-Island alternatives in July in Boston. A public meeting on the status of facilities planning, excluding the outfall work, was held in September. A public meeting devoted to the status of the outfall study will take place in November at two locations.

C. Meeting with Affected Communities--In addition to its attempts to educate the CAC and the public at-large, the Public Participation Program addresses the concerns of communities to be affected by the results of the decisions made during the study. The Authority's Community Relations liaison with the Town of Winthrop has attended monthly meetings of the Town's Representative Citizens Committee to keep them abreast, not only of ongoing operational and fast-track upgrade issues at the existing primary plant, but also of the progress of the Secondary Treatment Facilities Plan.

The Authority also holds regular public meetings with the Winthrop community at-large to update them on the STFP and to hear public concerns regarding key decisions. Similarly, the Authority's Boston/Quincy Community Relations Coordinator has attended monthly Nut Island CAC meetings. The Community Relations Coordinator for the northern sector of the MWRA service area provides similar coordination efforts to communities which may be potentially affected by outfall siting decisions.

Local elected and appointed officials are kept informed of all developments with the STFP relative to their concerns through the Public Participation and Community Relations Coordinators.

D. Other Meetings

A public hearing on the Secondary Treatment Facilities Plan/EIR will be conducted in December, 1987. Special request meetings with the MWRA Advisory Board and other groups and organizations have taken place.

E. Responsiveness Summaries

Responsiveness summaries of all public information meetings and public hearings are available within four (4) weeks after the public meeting.

## 12.6 OTHER INFORMATIONAL ACTIVITIES

The STFP project team has been involved in development of informational materials, including newsletters, public service announcements, press releases, an educational display, brochures, responsiveness summaries, and fact sheets for use at public and CAC meetings, as well as for distribution through mailing lists, repositories, schools, clubs, and other community information centers. The repositories are listed in Table 12.6-1.

The MWRA's computerized mailing list currently consists of over 2000 individuals, groups and agencies, which fall into the following categories:

- o MWRA Advisory Board (local officials)
- o Legislators (federal, state, regional, local)
- o Media
- o Agencies (federal, state, regional, local)
- o Groups/Organizations
- o Individuals

Attendees at public meetings are added to the mailing list.

## 12.7 PUBLIC PARTICIPATION SCHEDULE

The CAC meeting agenda is reviewed with the chairman and executive committee of the CAC prior to each meeting. The long-term agenda is reviewed with the CAC on a quarterly basis and updated as needed, with their input. For a complete listing of meetings that have taken place and planned meetings that pertain to this volume, please refer to the Public Participation Schedule shown in 12.7-1.

## TABLE 12.3-1

## CITIZENS' ADVISORY COMMITTEE
## REPRESENTATIVES AND ALTERNATES

Lois Baxter
17 Circuit Road
Winthrop, MA 02152
Alternate
846-3040 (h)

William Benson
52 Grinnell Street
Greenfield, MA 01301
Representative
(413) 773-5267

Peter Blanchard
Mass. Bankers Association
Prudential Tower, Suite 550
Boston, MA 02199
Representative
542-1837

Mike Brother
USGS
Quisset Campus
Woods Hole, MA 02543
Alternate
548-8700

Polly Bradley
SWIM
33 Summer Street
Nahant, MA 01908
Representative
581-0075

Brad Butman
USGS
Quisset Campus
Woods Hole, MA 02543
Representative
548-8700

Eugene Canty
2 Lafayette Terrace
Nahant, MA 01908
Alternate
581-0281

Michael Cheney
94 Rock Island Road
Quincy, MA 02169
Alternate
471-1493

Joseph F. Conoby
Honeywell Bull, Inc.
300 Concord Road
Billerica, MA 01821
Representative
671-3614

Sharon Dean
N. E. Aquarium
Central Wharf
Boston, MA 02110
Representative
973-6552

**TABLE 12.3-1**

**CITIZENS' ADVISORY COMMITTEE**
**REPRESENTATIVES AND ALTERNATES**
**(continued)**

Clifford deBaun
Sierra Club New England
1386-A Canton Ave.
Milton, MA 02186
Alternate
333-0173

Leonard DeModena
182 Pinceton Street
East Boston, MA 02128
Representative
727-1263 (w)

Emile DiMento
Winthrop Concerned Citizens
118 Woodside Ave.
Winthrop, MA 02152
Representative
826-9406

Joe Duggan
Greater Boston Chamber of Commerce
125 High Street
Boston, MA 02110
Representative
426-1250

William Elliott
2 Bargate Lane
Hadley, MA 01035
Representative
(413) 586-8861

Astrid Glynn
Glynn & Dempsey, P.C.
One Federal Street
Boston, MA 02110
Representative
523-7420

Lydia Goodhue
The Boston Harbor Associates
90 Dover Road
Wellesley, MA 02181
Representative
235-5370

Phillip Goodwin
Mass. Bay Yacht Clubs Assoc.
73 Bicknell Street
Quincy, MA 02169
Representative
471-5913

Alice Hennesey
Boston City Council
One City Hall Plaza
Boston, MA 02201
Alternate
725-4000

Stephen Hunt
Save the Harbor/Save the Bay
3 Joy Street
Boston, MA 02108
Alternate
742-7283

**TABLE 12.3-1**

**CITIZENS' ADVISORY COMMITTEE**
**REPRESENTATIVES AND ALTERNATES**
**(continued)**

Betsy Johnson
Mass. Audubon - Boston
3 Joy Street
Boston, MA 02108
Representative
367-1026

Ruth Kaminski
25 Moosehill Road
Leicester, MA 01524
Representative
892-3121

Mary Kelley
Winthrop Conservation
Commission
48 Sargent Street
Winthrop, MA 02152
Representative
846-9450

Robert Luongo
Office of Community Development
City Hall, 500 Broadway
Chelsea, MA 02150
Alternate
889-0700

Joseph MacRitchie
110 Sonoma Road
Squantum, MA 02171
Representative
773-1380

Tom McNiff
118 Grandview Ave.
Winthrop, MA 02152
Alternate
846-3782

Herbert Meyer
Mystic River Watershed Assoc.
276 Massachusetts Avenue
Arlington, MA 02174
Representative
643-2157

Phil Mitchell
Construction of Industries of Mass.
P.O. Box 667
Norwood, MA 02062
Alternate
551-0182

Martin Nee
c/o Rep. M. Flaherty
State House, Room 138
Boston, MA 02133
Representative
722-2396

Robert Noonan
Winthrop Board of Selectman
Town Hall
Winthrop, MA 02152
Representative
846-1852

Marjorie O'Neil
212 Chestnut Street
Brookline, MA 02146
Alternate
232-6260

Martin Pillsbury
Metropolitan Area Planning Council
110 Tremont Street
Boston, MA 02108
Representative
451-2770

**TABLE 12.3-1**

**CITIZENS' ADVISORY COMMITTEE**
**REPRESENTATIVES AND ALTERNATES**
**(continued)**

John Piotti
MWRA Advisory Board
6 Beacon Street, Room 925
Boston, MA 02108
Representative
742-7561

Stewart Sanders
Mystic River Watershed Assoc.
73 Fairmont Street
Belmont, MA 02178
Alternate
489-3120

John Scalcione
36 Frankfort Street
East Boston, MKA 02128
Representative
589-3926

Lawrence Schafer
26 Emerson Street
Newton, MA 02158
Representative
965-9888

Judith Schlosser
Office of Community Development
City Hall, 500 Broadway
Chelsea, MA 02150
Representative
889-0700 (w)

Eric Thomas
Utility Contractors Association
150 Wood Road, Suite 305
Braintree, MA 02184

Jack Walsh
63 Sea Avenue
Quincy, MA 02169
Representative
471-6191 (h)

Virginia Wilder
Office of Community Development
Town Hall
Winthrop, MA 02152
Alternate
846-1852

Nicholas Yannoni
31 Lafayette Road
Newton, MA 02162
Alternate
377-2206

**TABLE 12.4-1**

**TECHNICAL ADVISORY GROUP**

Karen Adams
US Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02154
TAG
647-8237

Libby Blank
Boston Water and Sewer Commission
10 Post Office Square
Boston, MA 02109
TAG
426-6046

Susan Bregman
Boston Traffic and Parking
Boston City Hall
Boston, MA 02201
TAG
565-3549

Leigh Bridges
Dept. of Fisheries, Wildlife & Env. Enf.
100 Cambridge Street, 19th Floor
Boston, MA 02202
TAG
727-3193

Eric Buehrens
Department of Environmental Mgmt.
225 Friend Street
Boston, MA 02114
TAG
727-3160

Ken Carr
US Fish & Wildlife Service
P.O. Box 1518
Concord, NH 03301
TAG

Roberta Ellis
MASSPORT Planning Department
10 Park Plaza
Boston, MA 02116
TAG
973-5390

David Graber
118 Larson Road
Stoughton, MA 02072
TAG
341-0390

Fred Hoskins
Executive Office of Enconomic Affairs
1 Ashburton Place
Boston, MA 02108
TAG
727-8380

Steve Lipman
DEQE/DWPC
One Winter Street
Boston, MA 02108
TAG
292-5698

Christopher Mantzaris
US Nat'l Marine Fisheries Serv.
14 Elm Street
Gloucester, MA 01930
TAG

Julia O'Brien
MDC Planning Office
20 Somerset Street
Boston, MA 02108
TAG
727-9693

**TABLE 12.4-1**

**TECHNICAL ADVISORY GROUP**
**(Continued)**

William Patterson
US DOI, Off. of Env. Proj. Review
15 State Street
Boston, MA 02109
TAG
223-5517

Myra Schwartz
BRA, Harbor Planning and Develop.
1 First Ave., 2nd Floor
Charlestown, MA 02129
TAG
242-2282

Brona Simon
Massachusetts Historical Commission
80 Boylston Street
Boston, MA 02216
TAG
727-8470

Linda Smith
BRA, Harbor Planning
1 First Ave., 2nd Floor
Charlestown, MA 02129
TAG
242-2282

Jan Smith
Office of Coastal Zone Mgmt.
100 Cambridge Street, 20th Floor
Boston, MA 02202
TAG
727-9530

David Standley
4 Spillers Lane
Ipswich, MA 02938
TAG
356-7174

Mike Tierney
Exec. Office of Communities & Development
100 Cambridge Street, 14th Floor
Boston, MA 02202
TAG
727-7765

Dave Tomey
US EPA
JFK Federal Bldg, Rm. 2100 B
Boston, MA 02203
TAG
565-3552

Lt. Commander Michael Wade
U.S. Coast Guard, Marine Safety Div.
477 Commercial Street
Boston, MA 02109
TAG
223-8441 (Douglas Brown)

Kim Zullo
MASSPORT Development Dept.
10 Park Plaza
Boston, MA 02116
TAG

## TABLE 12.6-1

## LIST OF REPOSITORIES

Winthrop Public Library
Attn: George Pillion
2 Metcalf Square
Winthrop, MA 02152
846-1703

Hours of service: Mon., Tues., Thurs. 1-9; Wed. 10-9; Fri. 10-6; Sat. 10-5

Thomas Crane Public Library
Attn: Linda Beeler--Reserve Dept.
40 Washington Street
Quincy, MA 02169
471-2400

Hours of service: Mon.-Thurs. 9-9; Wed. 10-9; Fri. 10-6; Sat. 10-5

Hough's Neck Community Center
Attn: Patricia Redlen
1193 Sea Street
Quincy, MA 02169

Hours of service: Mon. 9-8:30; Tues.-Fri. 9-4

Boston Public Library
Attn: Jennifer Nason
Document Dept./Rm. 341
State House
Boston, MA 02133
727-2590

Hours of service: Mon.-Fri. 9-5

Wellesley Public Library
530 Washington Street
Wellesley, MA 02181

Hours of service: Mon.-Thurs. 10-9; Fri. 10-7; Sat. 9-5; Sun. 2-5

**TABLE 12.6-1**

**LIST OF REPOSITORIES**
**(Continued)**

Malden Public Library
Walpole Street
Norwood, MA 02062

Hours of service: Mon.-Fri. 9-9; Sat. 9-5; Sun. 1-5

MWRA Library[1]
Attn: Mary Lyden
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
242-6000

Hours of service: Mon.-Fri. 8:30-5

[1] This is a central reference location with full project histories and other information available to CAC members and the public.

## TABLE 12.7-1

## PUBLIC PARTICIPATION SCHEDULE

| Project/Activity | October 1986 | November 1986 | January 1987 | February 1987 |
|---|---|---|---|---|
| CAC Meeting | 10/27 Intro. | 11/24 Public Participation Workplans | 1/5 Mitigation commitments and planning; Conceptual Site Layouts (Harbor Perspectives); Flows and Loads (preliminary) | 2/2 Flows and Loads; Environmental Scoping |
| Subcommittees | | | | 2/2 Scoping |
| Community Meetings, Hearings & Forums | | | 2 Community meetings, Winthrop 12/18 & Quincy 1/15, (Harbor Perspectives) | Forum 1/22 |
| Distribution of Materials | | Harbor Perspective Report | | Technical Memos:<br>- Flows and Loads<br>- Environmental Review Scope |

**TABLE 12.7-1**

**PUBLIC PARTICIPATION SCHEDULE**
**(Continued)**

| Project Activity | February 1987 | March 1987 | April 1987 | May 1987 |
|---|---|---|---|---|
| CAC Meeting | 2/23 Flows and Loads (WWTP size); Environmental Scope | 3/23 Draft report: - Evaluation Criteria | 4/27 Power; Site Development | 6/1 Special Meeting Site Tour Site Layouts |
| Subcommittees | | Evaluation Criteria 3/19 & 3/31 | | |
| Community Meetings, Hearings & Forums | | | 2 Community workshops Winthrop 4/22 & Quincy 4/30, (Site Layout) | |
| Distribution of Materials | Technical Memo: Evaluation Criteria | | | |

TABLE 12.7-1

## PUBLIC PARTICIPATION SCHEDULE
**(Continued)**

| Project Activity | June 1987 | July 1987 | August 1987 | September 1987 |
|---|---|---|---|---|
| CAC Meeting | 6/29 EPA EIS Historical & Archaeological | 7/27 Detailed Evaluation of Alternatives | | 9/28 Status Report: Implementation Schedule |
| Subcommittees | | Treatment Processes; Site Layouts | | |
| Community Meetings, Hearings & Forums | | 2 Community Workshops Winthrop 7/16 & Quincy 7/9, (Site Preparation & Site Layouts); Public Meeting, Boston, 7/23 (Site Preparation. Inter-Island and Site Layouts) | | Public Meeting, Boston 9/23 (FP/EIR |
| Distribution of Materials | Evaluation Criteria (non-outfall) | Tech. Memo: Treatment Processes & Site Layouts | Status Report: Mitigation | Status Report: Implementation Schedule |

**TABLE 12.7-1**

**PUBLIC PARTICIPATION SCHEDULE**
**(Continued)**

| Project Activity | October 1987 | November 1987 | December 1987 | January 1988 |
|---|---|---|---|---|
| CAC Meeting | Draft Facilities Plan/EIR, Vol III Treatment Plant | Facilities Plan EIR | Facilities Plan EIR | Facilities Plan EIR |
| Subcommittees | Deer Island Flows and Loads 10/1 & 10/19 | | | |
| Community Meetings, Hearings & Forums | Facilites Plan/EIR Public Meeting, Winthrop 10/13, Quincy 10/14, and Cambridge 10/15 | | Facilities Plan/EIR Hearing | Forum |
| Distribution of Materials | Draft Vol. III | | | |

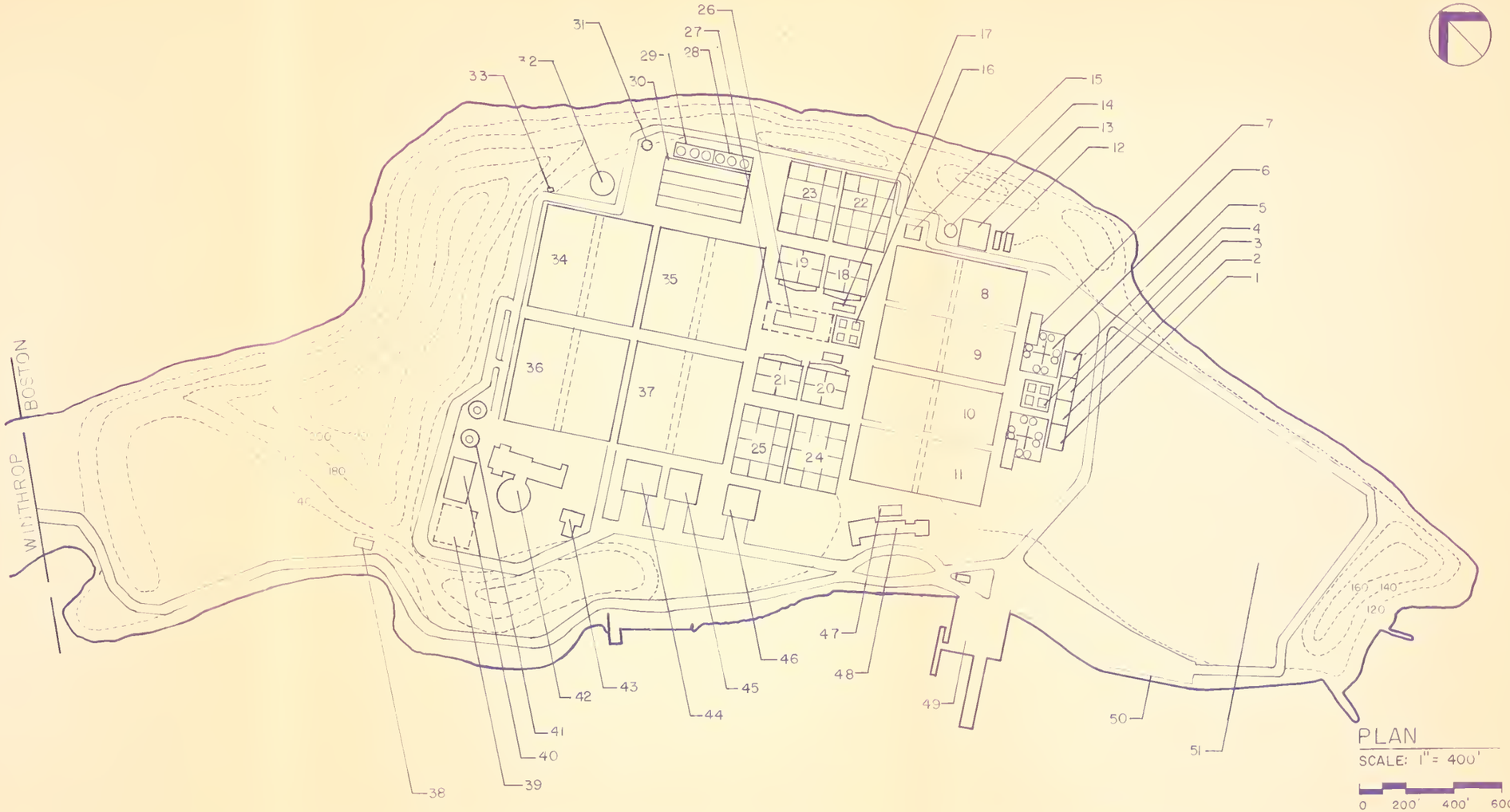
TABLE 12.7-1

## PUBLIC PARTICIPATION SCHEDULE
**(Continued)**

| Project/Activity | February 1988 | March 1988 | April 1988 | May 1988 |
|---|---|---|---|---|
| CAC Meeting | Facilities Plan<br>Env. Review | | | |
| Subcommittees | | | | |
| Community Meetings, Hearings & Forums | | | | Forum |
| Distribution of Materials | | Final Vol. III | | |

## LEGEND

1. GRIT HANDLING
2. PRIMARY OPERATIONS BUILDING
3. SOUTH SYSTEM PUMPING STATION
4. PRIMARY SPLITTER BOX
5. ELECTRICAL/MECHANICAL ROOMS
6. GRIT FACILITY (TYP OF 2)
7. PRIMARY ODOR CONTROL (TYP OF 2)
8. PRIMARY CLARIFIER BATTERY A
9. PRIMARY CLARIFIER BATTERY B
10. PRIMARY CLARIFIER BATTERY C
11. PRIMARY CLARIFIER BATTERY D
12. CRYOGENIC FACILITY (TYP OF 2)
13. COMPRESSOR BUILDING
14. LIQUID OXYGEN STORAGE
15. PRIMARY SCREENING
16. SECONDARY SPLITTER BOX
17. SECONDARY ODOR CONTROL (TYP OF 2)
18. ANAEROBIC SELECTOR BASIN A
19. ANAEROBIC SELECTOR BASIN B
20. ANAEROBIC SELECTOR BASIN C
21. ANAEROBIC SELECTOR BASIN D
22. AERATION BASIN BATTERY A
23. AERATION BASIN BATTERY B
24. AERATION BASIN BATTERY C
25. AERATION BASIN BATTERY D
26. SECONDARY OPERATIONS BUILDING
27. SECONDARY SLUDGE PUMP STATIONS
28. SODIUM HYPOCHLORITE STORAGE
29. SODIUM METABISULFIDE STORAGE
30. DISINFECTION BASINS
31. OUTFALL SHAFT
32. POTABLE WATER TANK
33. CEMETERY MARKER
34. SECONDARY CLARIFIER BATTERY A
35. SECONDARY CLARIFIER BATTERY B
36. SECONDARY CLARIFIER BATTERY C
37. SECONDARY CLARIFIER BATTERY D
38. GATE HOUSE
39. ELECTRICAL SUBSTATIONS
40. POWER FACILITIES
41. DIESEL STORAGE ( TYP OF 2 )
42. NORTH MAIN PUMPING STATION
43. WINTHROP TERMINAL
44. DRY STORAGE
45. VEHICLE MAINTENANCE
46. MAINTENANCE/WAREHOUSE
47. LABORATORY
48. ADMINISTRATION BUILDING
49. PIERS
50. BULKHEAD DOCKS
51. RESIDUAL PROCESSING




MASSACHUSETTS WATER RESOURCES AUTHORITY

FIGURE 11.1.3-1
RECOMMENDED DEER ISLAND FACILITIES

WATER RESOURCES AUTHORITY
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